THE "NEWEST" NAVIGATION

ALTITUDE
AND
AZIMUTH TABLES

THE SIMPLEST AND READIEST IN SOLUTION

By COMMANDER RADLER DE AQUINO
BRAZILIAN NAVY

SECOND STEREOTYPED EDITION
ENLARGED AND IMPROVED

Ready Reckoner and Altitude Correction Table

Number of minutes a, b, or Δd.

x +	0.'2	0.'4	0.'6	0.'8	1' or cos x	2'	3'	4'	5'	6'	7'	8'	9'	10'	11'	12'	13'	14'	15'	sec x	x −
°																					
0	.20	.40	.60	.80	1.00	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	1.00	180
10	.20	.39	.59	.79	0.98	2.0	3.0	3.9	4.9	5.9	6.9	7.9	8.9	9.8	10.8	11.8	12.8	13.8	14.8	1.02	170
14	.19	.39	.58	.78	.97	1.9	2.9	3.9	4.9	5.8	6.8	7.8	8.7	9.7	10.7	11.6	12.6	13.6	14.6	1.03	166
16	.19	.38	.58	.77	.96	1.9	2.9	3.8	4.8	5.8	6.7	7.7	8.7	9.6	10.6	11.5	12.5	13.5	14.4	1.04	164
18	.19	.38	.57	.76	.95	1.9	2.9	3.8	4.8	5.7	6.7	7.6	8.6	9.5	10.5	11.4	12.4	13.3	14.3	1.05	162
20	.19	.38	.56	.75	0.94	1.9	2.8	3.8	4.7	5.6	6.6	7.5	8.5	9.4	10.3	11.3	12.2	13.2	14.1	1.06	160
22	.19	.37	.56	.74	.93	1.9	2.8	3.7	4.6	5.6	6.5	7.4	8.3	9.3	10.2	11.1	12.1	13.0	13.9	1.08	158
24	.18	.37	.55	.73	.91	1.8	2.7	3.7	4.6	5.5	6.4	7.3	8.2	9.1	10.0	11.0	11.9	12.8	13.7	1.09	156
26	.18	.36	.54	.72	.90	1.8	2.7	3.6	4.5	5.4	6.3	7.2	8.1	9.0	9.9	10.8	11.7	12.6	13.5	1.11	154
28	.18	.35	53	.71	.88	1.8	2.6	3.5	4.4	5.3	6.2	7.1	7.9	8.8	9.7	10.6	11.5	12.4	13.2	1.13	152
30	.17	.35	.52	.69	0.87	1.7	2.6	3.5	4.3	5.2	6.1	6.9	7.8	8.7	9.5	10.4	11.3	12.1	13.0	1.15	150
31	.17	.34	.51	.69	.86	1.7	2.6	3.4	4.3	5.1	6.0	6.9	7.7	8.6	9.4	10.3	11.1	12.0	12.9	1.17	149
32	.17	.34	.51	.68	.85	1.7	2.5	3.4	4.2	5.1	5.9	6.8	7.6	8.5	9.3	10.2	11.0	11.9	12.7	1.18	148
33	.17	.34	.50	.67	.84	1.7	2.5	3.4	4.2	5.0	5.9	6.7	7.5	8.4	9.2	10.1	10.9	11.7	12.6	1.19	147
34	.17	.33	.50	.66	.83	1.7	2.5	3.3	4.1	5.0	5.8	6.6	7.5	8.3	9.1	9.9	10.8	11.6	12.4	1.21	146
35	.16	.33	.49	.66	0.82	1.6	2.5	3.3	4.1	4.9	5.7	6.6	7.4	8.2	9.0	9 8	10 6	11 5	12.3	1.22	145
36	.16	.32	.49	.65	.81	1.6	2.4	3.2	4.0	4.9	5 7	6.5	7.3	8.1	8.9	9 7	10 5	11.3	12 1	1.24	144
37	.16	.32	.48	64	.80	1.6	2.4	3.2	4.0	4.8	5.6	6.4	7.2	8 0	8 8	9.6	10 4	11.2	12.0	1.25	143
38	.16	.32	.47	.63	.79	1.6	2.4	3.2	3.9	4 7	5.5	6.3	7.1	7 9	8.7	9.5	10 2	11.0	11.8	1.27	142
39	.16	.31	.47	.62	.78	1.6	2.3	3.1	3.9	4.7	5.4	6.2	7.0	7.8	8.5	9.3	10.1	10.9	11.7	1.29	141
40	.15	.31	.46	.61	0.77	1.5	2.3	3.1	3.8	4.6	5.4	6.1	6.9	7.7	8.4	9.2	10.0	10.7	11.5	1.31	140
41	.15	.30	.45	.60	.75	1.5	2.3	3.0	3.8	4.5	5.3	6.0	6.8	7.5	8.3	9.1	9.8	10.6	11.3	1.33	139
42	.15	.30	.45	.59	.74	1.5	2.2	3.0	3.7	4.5	5.2	5.9	6.7	7.4	8.2	8.9	9.7	10.4	11.1	1.35	138
43	.15	.29	.44	.59	.73	1.5	2.2	2.9	3.7	4.4	5.1	5.9	6.6	7.3	8.0	8.8	9.5	10.2	11.0	1.37	137
44	.14	.29	.43	.58	.72	1.4	2.2	2.9	3.6	4.3	5.0	5.8	6.5	7.2	7.9	8.6	9.4	10.1	10.8	1.39	136
45	.14	.28	.42	.57	0.71	1.4	2.1	2.8	3.5	4.2	4.9	5.7	6.4	7.1	7.8	8.5	9.2	9.9	10.6	1.41	135
46	.14	.28	.42	.56	.69	1.4	2.1	2.8	3.5	4.2	4.9	5.6	6.3	6.9	7.6	8.3	9.0	9.7	10.4	1.44	134
47	.14	.27	.41	.55	.68	1.4	2.0	2.7	3.4	4.1	4.8	5.5	6.1	6.8	7.5	8.2	8.9	9.5	10.2	1.47	133
48	.13	.27	.40	.54	.67	1.3	2.0	2.7	3.3	4.0	4.7	5.4	6.0	6.7	7.4	8.0	8.7	9.4	10.0	1.49	132
49	.13	.26	.39	.52	.66	1.3	2.0	2.6	3.3	3.9	4.6	5.2	5.9	6.6	7.2	7.9	8.5	9.2	9.8	1.52	131
50	.13	.26	.39	.51	0.64	1.3	1.9	2.6	3.2	3.9	4.5	5.1	5.8	6.4	7.1	7.7	8.4	9.0	9.6	1.56	130
51	.13	.25	.38	.50	.63	1.3	1.9	2.5	3.1	3.8	4.4	5.0	5.7	6.3	6.9	7.6	8.2	8.8	9.4	1.59	129
52	.12	.25	.37	.49	.62	1.2	1.8	2.5	3.1	3.7	4.3	4.9	5.5	6.2	6.8	7.4	8.0	8.6	9.2	1.62	128
53	.12	.24	.36	.48	.60	1.2	1.8	2.4	3.0	3.6	4.2	4.8	5.4	6.0	6.6	7.2	7.8	8.4	9.0	1.66	127
54	.12	.24	.35	.47	.59	1.2	1.8	2.4	2.9	3.5	4.1	4.7	5.3	5.9	6.5	7.1	7.6	8.2	8.8	1.70	126
55	.11	.23	.34	.46	0.57	1.1	1.7	2.3	2.9	3.4	4.0	4.6	5.2	5.7	6.3	6.9	7.5	8.0	8.6	1.74	125
56	.11	.22	.34	.45	.56	1.1	1.7	2.2	2.8	3.4	3.9	4.5	5.0	5.6	6.2	6.7	7.3	7.8	8.4	1.79	124
57	.11	.22	.33	.44	.54	1.1	1.6	2.2	2.7	3.3	3.8	4.4	4.9	5.4	6.0	6.5	7.1	7.6	8.2	1.84	123
58	.11	.21	.32	.42	.53	1.1	1.6	2.1	2.6	3.2	3.7	4.2	4.8	5.3	5.8	6.4	6 9	7.4	7.9	1.89	122
59	.10	.21	.31	.41	.52	1.0	1.5	2.1	2.6	3.1	3.6	4.1	4.6	5.2	5.7	6.2	6.7	7.2	7.7	1.94	121
60	.10	.20	.30	.40	0.50	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	2.00	120
61	.10	.19	.29	.39	.48	1.0	1.5	1.9	2.4	2.9	3.4	3.9	4.4	4.8	5.3	5.8	6.3	6.8	7.3	2.06	119
62	.09	.19	.28	.38	.47	0.9	1.4	1.9	2.3	2.8	3.3	3.8	4.2	4.7	5.2	5.6	6.1	6.6	7.0	2.13	118
63	.09	.18	.27	.36	.45	0.9	1.4	1.8	2.3	2.7	3.2	3.6	4.1	4.5	5.0	5.4	5.9	6.4	6.8	2.20	117
64	.09	.18	.26	.35	.44	0.9	1.3	1.8	2.2	2.6	3.1	3.5	3.9	4.4	4.8	5.3	5.7	6.1	6.6	2.28	116
65	.08	.17	.25	.34	0.42	0.8	1.3	1.7	2.1	2.5	3.0	3.4	3.8	4.2	4.6	5.1	5.5	5.9	6.3	2.37	115
66	.08	.16	.24	.33	.41	0.8	1.2	1.6	2.0	2.4	2.8	3.3	3.7	4.1	4.5	4.9	5.3	5.7	6.1	2.46	114
67	.08	.16	.23	.31	.39	0.8	1.2	1.6	2.0	2.3	2.7	3.1	3.5	3.9	4.3	4.7	5.1	5.5	5.9	2.56	113
68	.07	.15	.22	.30	.37	0.7	1.1	1.5	1.9	2.2	2.6	3.0	3.4	3.7	4.1	4.5	4.9	5.2	5.6	2.67	112
69	.07	.14	.22	.29	.36	0.7	1.1	1.4	1.8	2.2	2.5	2.9	3.2	3.6	3.9	4.3	4.7	5.0	5.4	2 79	111
70	.07	.14	.21	.27	0.34	0.7	1.0	1.4	1.7	2.1	2.4	2.7	3.1	3.4	3.8	4.1	4.4	4.8	5.1	2.92	110
71	.07	.13	.20	.26	.33	0.7	1.0	1.3	1.6	2.0	2.3	2.6	2.9	3.3	3.6	3.9	4.2	4.6	4.9	3 07	109
72	.06	.12	.19	.25	.31	0.6	0.9	1.2	1.5	1.9	2.2	2.5	2.8	3.1	3.4	3.7	4.0	4.3	4.6	3.24	108
73	.06	.12	.18	.23	.29	0.6	0.9	1.2	1.5	1.8	2.0	2.3	2.6	2.9	3.2	3.5	3.8	4.1	4.4	3.42	107
74	.06	.11	.17	.22	.28	0.6	0.8	1.1	1.4	1.7	1.9	2.2	2.5	2.8	3.0	3.3	3.6	3.9	4.1	3.63	106
75	.05	.10	.16	.21	0.26	0.5	0 8	1.0	1.3	1.6	1.8	2.1	2.3	2.6	2.8	3.1	3.4	3.6	3.9	3.86	105
76	.05	.10	.15	.19	.24	0.5	0.7	1.0	1.2	1.5	1.7	1.9	2.2	2.4	2.7	2.9	3.1	3.4	3.6	4.13	104
77	.04	.09	.13	.18	.22	0.4	0.7	0.9	1.1	1.3	1.6	1.8	2.0	2.2	2.5	2.7	2.9	3.1	3.4	4.45	103
78	.04	.08	.12	.17	.21	0.4	0.6	0.8	1.0	1.2	1.5	1.7	1.9	2.1	2.3	2.5	2.7	2.9	3.1	4.81	102
79	.04	.08	.11	.15	.19	0.4	0.6	0.8	1.0	1.1	1.3	1.5	1.7	1.9	2.1	2.3	2.5	2.7	2.9	5.24	101
80	.03	.07	.10	.14	0.17	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.6	1.7	1.9	2.1	2.3	2.4	2.6	5 76	100
81	.03	.06	.09	.13	.16	0.3	0.5	0.6	0.8	0.9	1.1	1.3	1.4	1.6	1.7	1.9	2.0	2.2	2.3	6.39	99
82	.03	.06	.08	.11	.14	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.3	1.4	1.5	1.7	1.8	1.9	2.1	7.19	98
83	.02	.05	.07	.10	.12	0.2	0.4	0.5	0.6	0.7	0.9	1.0	1.1	1.2	1.3	1.5	1.6	1.7	1.8	8.21	97
84	.02	.04	.06	.08	.10	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.3	1.4	1.5	1.6	9.57	96
85	.02	.03	.05	.07	0.09	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.1	1.2	1.3	11.5	95
86	.01	.03	.04	.06	.07	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7	0.8	0.8	0.9	1.0	1.0	14.3	94
87	.01	.02	.03	.04	.05	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	19 1	93
88	.01	.01	.02	.03	.03	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.5	28.7	92
89	.00	.01	.01	.01	.02	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.3	57.3	91
90	.00	.00	.00	.00	.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	∞	90

Ready Reckoner and Altitude Correction Table

Number of minutes a, b, or Δd.

x +	cos x	16′	17′	18′	19′	20′	21′	22′	23′	24′	25′	26′	27′	28′	29′	30′	sec x	x −
°																		°
0	1.00	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25.0	26.0	27.0	28.0	29.0	30.0	1.00	180
10	0.98	15.8	16.7	17.7	18.7	19.7	20.7	21.7	22.7	23.6	24.6	25.6	26.6	27.6	28.6	29.5	1.02	170
14	.97	15.5	16.5	17.5	18.4	19.4	20.4	21.3	22.3	23.3	24.3	25.2	26.2	27.2	28.1	29.1	1.03	166
16	.96	15.4	16.3	17.3	18.3	19.2	20.2	21.1	22.1	23.1	24.0	25.0	26.0	26.9	27.9	28.8	1.04	164
18	.95	15.2	16.2	17.1	18.1	19.0	20.0	20.9	21.9	22.8	23.8	24.7	25.7	26.6	27.6	28.5	1.05	162
20	0.94	15.0	16.0	16.9	17.9	18.8	19.7	20.7	21.6	22.6	23.5	24.4	25.4	26.3	27.3	28.2	1.06	160
22	.93	14.8	15.8	16.7	17.6	18.5	19.5	20.4	21.3	22.3	23.2	24.1	25.0	26.0	26.9	27.8	1.08	158
24	.91	14.6	15.5	16.4	17.4	18.3	19.2	20.1	21.0	21.9	22.8	23.8	24.7	25.6	26.5	27.4	1.09	156
26	.90	14.4	15.3	16.2	17.1	18.0	18.9	19.8	20.7	21.6	22.5	23.4	24.3	25.2	26.1	27.0	1.11	154
28	.88	14.1	15.0	15.9	16.8	17.7	18.5	19.4	20.3	21.2	22.1	23.0	23.8	24.7	25.6	26.5	1.13	152
30	0.87	13.9	14.7	15.6	16.5	17.3	18.2	19.1	19.9	20.8	21.7	22.5	23.4	24.2	25.1	26.0	1.15	150
31	.86	13.7	14.6	15.4	16.3	17.1	18.0	18.9	19.7	20.6	21.4	22.3	23.1	24.0	24.9	25.7	1.17	149
32	.85	13.6	14.4	15.3	16.1	17.0	17.8	18.7	19.5	20.4	21.2	22.0	22.9	23.7	24.6	25.4	1.18	148
33	.84	13.4	14.3	15.1	15.9	16.8	17.6	18.5	19.3	20.1	21.0	21.8	22.6	23.5	24.3	25.2	1.19	147
34	.83	13.3	14.1	14.9	15.8	16.6	17.4	18.2	19.1	19.9	20.7	21.6	22.4	23.2	24.0	24.9	1.21	146
35	0.82	13.1	13.9	14.7	15.6	16.4	17.2	18.0	18.8	19.7	20.5	21.3	22.1	22.9	23.8	24.6	1.22	145
36	.81	12.9	13.8	14.6	15.4	16.2	17.0	17.8	18.6	19.4	20.2	21.0	21.8	22.7	23.5	24.3	1.24	144
37	.80	12.8	13.6	14.4	15.2	16.0	16.8	17.6	18.4	19.2	20.0	20.8	21.6	22.4	23.2	24.0	1.25	143
38	.79	12.6	13.4	14.2	15.0	15.8	16.5	17.3	18.1	18.9	19.7	20.5	21.3	22.1	22.9	23.6	1.27	142
39	.78	12.4	13.2	14.0	14.8	15.5	16.3	17.1	17.9	18.7	19.4	20.2	21.0	21.8	22.5	23.3	1.29	141
40	0.77	12.3	13.0	13.8	14.6	15.3	16.1	16.9	17.6	18.4	19.2	19.9	20.7	21.4	22.2	23.0	1.31	140
41	.75	12.1	12.8	13.6	14.3	15.1	15.8	16.6	17.4	18.1	18.9	19.6	20.4	21.1	21.9	22.6	1.33	139
42	.74	11.9	12.6	13.4	14.1	14.9	15.6	16.3	17.1	17.8	18.6	19.3	20.1	20.8	21.6	22.3	1.35	138
43	.73	11.7	12.4	13.2	13.9	14.6	15.4	16.1	16.8	17.6	18.3	19.0	19.7	20.5	21.2	21.9	1.37	137
44	.72	11.5	12.2	12.9	13.7	14.4	15.1	15.8	16.5	17.3	18.0	18.7	19.4	20.1	20.9	21.6	1.39	136
45	0.71	11.3	12.0	12.7	13.4	14.1	14.8	15.6	16.3	17.0	17.7	18.4	19.1	19.8	20.5	21.2	1.41	135
46	.69	11.1	11.8	12.5	13.2	13.9	14.6	15.3	16.0	16.7	17.4	18.1	18.8	19.5	20.1	20.8	1.44	134
47	.68	10.9	11.6	12.3	13.0	13.6	14.3	15.0	15.7	16.4	17.0	17.7	18.4	19.1	19.8	20.5	1.47	133
48	.67	10.7	11.4	12.0	12.7	13.4	14.1	14.7	15.4	16.1	16.7	17.4	18.1	18.7	19.4	20.1	1.49	132
49	.66	10.5	11.2	11.8	12.5	13.1	13.8	14.4	15.1	15.7	16.4	17.1	17.7	18.4	19.0	19.7	1.52	131
50	0.64	10.3	10.9	11.6	12.2	12.9	13.5	14.1	14.8	15.4	16.1	16.7	17.4	18.0	18.6	19.3	1.56	130
51	.63	10.1	10.7	11.3	12.0	12.6	13.2	13.8	14.5	15.1	15.7	16.4	17.0	17.6	18.3	18.9	1.59	129
52	.62	9.9	10.5	11.1	11.7	12.3	12.9	13.5	14.2	14.8	15.4	16.0	16.6	17.2	17.9	18.5	1.62	128
53	.60	9.6	10.2	10.8	11.4	12.0	12.6	13.2	13.8	14.4	15.0	15.6	16.2	16.9	17.5	18.1	1.66	127
54	.59	9.4	10.0	10.6	11.2	11.8	12.3	12.9	13.5	14.1	14.7	15.3	15.9	16.5	17.0	17.6	1.70	126
55	0.57	9.2	9.8	10.3	10.9	11.5	12.0	12.6	13.2	13.8	14.3	14.9	15.5	16.1	16.6	17.2	1.74	125
56	.56	8.9	9.5	10.1	10.6	11.2	11.7	12.3	12.9	13.4	14.0	14.5	15.1	15.7	16.2	16.8	1.79	124
57	.54	8.7	9.3	9.8	10.3	10.9	11.4	12.0	12.5	13.1	13.6	14.2	14.7	15.2	15.8	16.3	1.84	123
58	.53	8.5	9.0	9.5	10.1	10.6	11.1	11.7	12.2	12.7	13.2	13.8	14.3	14.8	15.4	15.9	1.89	122
59	.52	8.2	8.8	9.3	9.8	10.3	10.8	11.3	11.8	12.4	12.9	13.4	13.9	14.4	14.9	15.5	1.94	121
60	0.50	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	2.00	120
61	.48	7.8	8.2	8.7	9.2	9.7	10.2	10.7	11.2	11.6	12.1	12.6	13.1	13.6	14.1	14.5	2.06	119
62	.47	7.5	8.0	8.5	8.9	9.4	9.9	10.3	10.8	11.3	11.7	12.2	12.7	13.1	13.6	14.1	2.13	118
63	.45	7.3	7.7	8.2	8.6	9.1	9.5	10.0	10.4	10.9	11.3	11.8	12.3	12.7	13.2	13.6	2.20	117
64	.44	7.0	7.5	7.9	8.3	8.8	9.2	9.6	10.1	10.5	11.0	11.4	11.8	12.3	12.7	13.2	2.28	116
65	0.42	6.8	7.2	7.6	8.0	8.5	8.9	9.3	9.7	10.1	10.6	11.0	11.4	11.8	12.3	12.7	2.37	115
66	.41	6.5	6.9	7.3	7.7	8.1	8.5	8.9	9.4	9.8	10.2	10.6	11.0	11.4	11.8	12.2	2.46	114
67	.39	6.3	6.6	7.0	7.4	7.8	8.2	8.6	9.0	9.4	9.8	10.2	10.5	10.9	11.3	11.7	2.56	113
68	.37	6.0	6.4	6.7	7.1	7.5	7.9	8.2	8.6	9.0	9.4	9.7	10.1	10.5	10.9	11.2	2.67	112
69	.36	5.7	6.1	6.5	6.8	7.2	7.5	7.9	8.2	8.6	9.0	9.3	9.7	10.0	10.4	10.8	2.79	111
70	0.34	5.5	5.8	6.2	6.5	6.8	7.2	7.5	7.9	8.2	8.6	8.9	9.2	9.6	9.9	10.3	2.92	110
71	.33	5.2	5.5	5.9	6.2	6.5	6.8	7.2	7.5	7.8	8.1	8.5	8.8	9.1	9.4	9.8	3.07	109
72	.31	4.9	5.3	5.6	5.9	6.2	6.5	6.8	7.1	7.4	7.7	8.0	8.3	8.7	9.0	9.3	3.24	108
73	.29	4.7	5.0	5.3	5.6	5.8	6.1	6.4	6.7	7.0	7.3	7.6	7.9	8.2	8.5	8.8	3.42	107
74	.28	4.4	4.7	5.0	5.2	5.5	5.8	6.1	6.3	6.6	6.9	7.2	7.4	7.7	8.0	8.3	3.63	106
75	0.26	4.1	4.4	4.7	4.9	5.2	5.4	5.7	6.0	6.2	6.5	6.7	7.0	7.2	7.5	7.8	3.86	105
76	.24	3.9	4.1	4.4	4.6	4.8	5.1	5.3	5.6	5.8	6.0	6.3	6.5	6.8	7.0	7.3	4.13	104
77	.22	3.6	3.8	4.0	4.3	4.5	4.7	4.9	5.2	5.4	5.6	5.8	6.1	6.3	6.5	6.7	4.45	103
78	.21	3.3	3.5	3.7	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	6.2	4.81	102
79	.19	3.1	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.3	5.5	5.7	5.24	101
80	0.17	2.8	3.0	3.1	3.3	3.5	3.6	3.8	4.0	4.2	4.3	4.5	4.7	4.9	5.0	5.2	5.76	100
81	.16	2.5	2.7	2.8	3.0	3.1	3.3	3.4	3.6	3.8	3.9	4.1	4.2	4.4	4.5	4.7	6.39	99
82	.14	2.2	2.4	2.5	2.6	2.8	2.9	3.1	3.2	3.3	3.5	3.6	3.8	3.9	4.0	4.2	7.19	98
83	.12	1.9	2.1	2.2	2.3	2.4	2.6	2.7	2.8	2.9	3.0	3.2	3.3	3.4	3.5	3.7	8.21	97
84	.10	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	9.57	96
85	0.09	1.4	1.5	1.6	1.7	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.4	2.5	2.6	11.5	95
86	.07	1.1	1.2	1.3	1.3	1.4	1.5	1.5	1.6	1.7	1.7	1.8	1.9	2.0	2.0	2.1	14.3	94
87	.05	0.8	0.9	0.9	1.0	1.0	1.1	1.2	1.2	1.3	1.3	1.4	1.4	1.5	1.5	1.6	19.1	93
88	.03	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.9	0.9	0.9	1.0	1.0	1.0	28.7	92
89	.02	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	57.3	91
90	.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	∞	90

The "Newest" Navigation Altitude and Azimuth Tables, by Commander Radler de Aquino, Brazilian Navy, second edition, enlarged and improved, London, 1918. Published by J. D. Potter, 145 Minories, London, E. Price 12s. net.

A slightly improved method of finding the Altitude and Azimuth by means of my Tables has been developed recently whereby it is not necessary to *interpolate* and find the true values of b and t for the true value of declination d, as explained on pages xv, xxi, and xxv of my Tables. It is sufficient to find only in column a the values of b (generally a whole degree) and of t that correspond to an approximate value of d. This approximate value of d is *always* the tabular value nearest to the true value, provided $t_{A.}$ is near $t_{D.R.}$ b is combined in the usual way with $L_{A.}$ (also generally the whole degree nearest the dead-reckoning latitude) to find C, and h' and Z' are found corresponding to the a and C. Now as h' and Z' are for the tabular value of d, we must correct them for the difference Δd between this tabular value and the true value of the declination.[1] We know from page xvii that a change of altitude h for a given change of declination Δd is given by the formula: $\Delta h = \Delta d \cos M$, where M is the parallactic angle. If we call, in Fig. 2 on page xii, the angle mMP : α and the angle mMZ : β, we have $M = \alpha + \beta$.

The value of a is found on the same line with b, d, and t (a being practically the same for all three values of a). In the same way β is found on the same line opposite C, h, and Z.

However, instead of finding C with $L_{A.}$ and b, it is in the great majority of cases better to find $L_{A.}$ from b and C, as explained below.

The working out of our typical example on page xix will show the great advantage of this improvement.

$a = 52°\ 0'$ G. A. T. $= 20^h\ 59^m\ 24^s$ or $t_{G.} = 314°\ 51'$ Pages 69 and 122, 2d. ed. 1912.

$L_{A.} = 37°$ N $\quad d = 10°\ 27'$ S

$b = 17°$ ..... $d' = 10°\ 22'$ ..... $t_{A.} = 53°\ 14'$ E ..... $a = 76°.5$

$d - d' = +5'$ $\quad G_{A.} = 8°\ 5'$ W

$C = 54°$ ..... $h' = 21°\ 13'$ ..... $Z'_{A.} = $ S $57°\ 42'$ E ..... $\beta = 60°.4$

$\Delta h = -3'.7$ $\quad M = 136°.9$

$h_{A.} = 21°\ 9'.3$

$h = 21\ 7$

$h - h_{A.} = -2'.3$

NOTE.—Numbers taken out of the Tables by Inspection are black-faced in order to distinguish them from data given or found.

In addition to the formulæ given on page xxviii for finding $L_{A.}$ with b and C, we have added those for finding M with a and β.

d and $L_{A.}$ same name $\begin{cases} t < 90° \begin{cases} L_{A.} < b : L_{A.} = b - C \text{ and } M = a + \beta \\ L_{A.} > b : L_{A.} = b + C \text{ and } M = a - \beta \end{cases} \\ t > 90° \ldots\ldots : L_{A.} = C + b \text{ and } M = \beta - a \end{cases}$

d and $L_{A.}$ contrary names ..... $: L_{A.} = C - b$ and $M = a + \beta$

When $t > 90°$ the sum $C + b > 90°$ also, and we must subtract it from 180° to obtain $L_{A.}$

A simple inspection of these formulæ shows that no different rules are necessary with this new process. A knowledge of the approximate value of $L_{A.}$ is *always* known by dead-reckoning, and therefore, we can immediately find, in view of the fact that b and $L_{A.}$ are generally whole degrees, the value of C that combined with b will give us $L_{A.}$ The tabular value h' nearest to the true altitude h shows us opposite it also the value of C.

The formulæ show also that when we *subtract* b and C to find $L_{A.}$, we must add a and β to obtain M. When we *add* b and C to find $L_{A.}$ we must *subtract* a and β from one another to obtain M.

The "Altitude correction" $\Delta h = 3'.7$ is given immediately by our Table[2] on the back, where we enter at the top with $\Delta d = 5'$, and with $M = 137°$ on the right hand side. If M is less than 90°, enter the table on the left hand side. The correction has the same sign as $d - d'$ or Δd when M is less than 90° and the contrary sign to $d - d'$ or Δd when M is greater than 90°.

In this way Altitude and Azimuth from the assumed position are found by means of simple mnemonical rules *without* interpolating.

[1] As Δd is generally only a few minutes of arc, Z' does not need in practice any correction. The formula on page xvii: $\Delta Z = \sin M \sec h\ \Delta d$ shows us that ΔZ is *always* smaller than $\sec h\ \Delta d$. Under $h = 60°$, ΔZ is always smaller than $2\Delta d$.

[2] Also by our Plane Traverse Tables in LAT. column if we enter them with Δd as D and with M or $180° - M$ as Course.

THE "NEWEST" NAVIGATION
ALTITUDE AND AZIMUTH TABLES

ATTENTION!

Would you ever think of going to the trouble of calculating the elements of the NAUTICAL ALMANAC, viz. declination, right ascension, equation of time, &c., by means of formulæ and logarithms, when His Majesty's NAUTICAL ALMANAC Office tabulates these data every year? Certainly not.

Would you ever think of working out your dead-reckoning by means of formulæ and logarithms when the Plane Traverse Tables facilitate the direct solution of all problems related thereto? Not at all!

Why then go to the trouble to solve the astronomical triangle of position by means of complicated formulæ and logarithms when we have tabulated its elements in our "Altitude and Azimuth Tables" (Spherical Traverse Tables) and have given the simplest and readiest methods for solving all problems related thereto?

HOWEVER,

If you do not like the method for finding the *altitude* using an *assumed position*, use then the new Altitude Tables at the end of this book, and methods explained on page xxxviii for the *azimuth.*

They are also the "*simplest and readiest in solution.*"

THE "NEWEST" NAVIGATION

ALTITUDE
AND
AZIMUTH TABLES

FOR FACILITATING THE DETERMINATION OF LINES OF POSITION AND GEOGRAPHICAL POSITION AT SEA

THE SIMPLEST AND READIEST IN SOLUTION

Plane and Spherical Traverse Tables for Solving all Problems of Navigation

By COMMANDER RADLER DE AQUINO
BRAZILIAN NAVY

SECOND STEREOTYPED EDITION

ENLARGED AND IMPROVED

Sights "may be practically worked out so as to give the ship's place as accurately as it can be deduced from the observations, with hardly any calculation. . . . .
. . . . . .

"One of the advantages in the use of this method is that no logarithmic work is required."

SIR WILLIAM THOMSON (LORD KELVIN). "Tables for Facilitating Sumner's Method at Sea." London, 1876. pp. iv. and v.

"È facile persuadersi che, dopo avere acquistata un po' di pratica, le operazioni descritte possono esser fatte con grande speditezza: l' uso della Tavola è facile e le regole da applicare sono indiscutibilmente semplici."

DOTT. ALBERTO ALESSIO, R.I.N. "Sulla Teoria e la Pratica della Nuova Navigazione Astronomica." *Rivista Marittima* for March 1909, Appendice, p. 59.

1918

LONDON
PUBLISHED BY
J. D. POTTER
Admiralty Agent for Charts
145, MINORIES, E. 1.

RIO DE JANEIRO
D. NORRIS
Sub-Agent for Charts
36, RUA DA ASSEMBLEA

PRICE 12/- NET.

Printed for the Author by
Spottiswoode, Ballantyne & Co. Ltd.
London, Colchester and Eton.

EXPRESSION OF OPINION

NAVY DEPARTMENT.

COPIA. WASHINGTON.

February 1, 1909.

SIR: Replying to your letter No. 17512, of the 21st ultimo, enclosing a copy of a letter from the Brazilian Ambassador, requesting an expression of the Department's opinion as to the scientific merit of the altitude and azimuth tables prepared by the Naval Attaché to his Embassy, of which you enclosed a copy and description, I have the honor to inform you that the Hydrographer of the U.S. Navy, to whom your letter and enclosures were referred, has submitted the following report, which is quoted for your information:

"Existing tables give the distance and bearing, on the globe or the celestial sphere or any other sphere, of any place from every other place, and consequently the zenith distance and bearing, that any celestial body would have at any given time to an observer situated in any geographical position. So that, an observer in a geographical position as yet unknown, about to measure the altitude of a celestial body for position, may assume beforehand a geographical position in the region of his station and find from the tables the zenith distance and bearing which the celestial body would have if observed from the assumed position; and then, comparing the zenith distance, so taken from the tables, with the zenith distance shown by the measured altitude, may at once find the Sumner line by laying off from the assumed geographical position, in the direction of the bearing, an intercept equal to the difference of these zenith distances and drawing at right angles to the bearing through the point thus found. All cases of cœlo-navigation are thus brought under a single rule.

"Aquino's purpose is to abridge the extent of the existing tables by tabulating the solutions of the two right-angled spherical triangles, into which the astronomical triangle may always be divided, with values of the argument no nearer together than 30′ in one case, and 1° in the other. To make this plan feasible, his purpose is to sacrifice the freedom of choice now existing with reference to the assumed geographical position, and, by short calculation, to find instead an auxiliary geographical position so placed that the proposed tables may be entered without interpolation between the tabular values of the arguments, which are, in fact, designedly spaced too far apart for successful interpolation. The advantage of having one simple rule for the solution of all cases is also somewhat disturbed by necessary variations from the singleness of the rule in order to adapt the proposed tables to varying combinations of data arising from different relative positions of the observer and the observed celestial body.

"The plan of the proposed work, as outlined in the enclosed publications,[1] is sound in principle and scientific in conception; and the tables will possess the merit of being compressed into a small book."

I have the honor to be, Sir,

Very respectfully,

TRUMAN H. NEWBERRY,

Secretary.

THE HONORABLE
THE SECRETARY OF STATE.

Seal.

Confere.
E. L. CHERMONT.

Conforme com o original no Archivo da Embaixada do Brazil em Washington.
SYLVINO GURGEL DO AMARAL,
Conselheiro de Embaixada.

---

[1] "A Navegação sem logarithmos." *Imprensa Nacional*, Rio de Janeiro, 1903, and "Altitude and Azimuth Tables for facilitating the Determination of Lines of Position and Geographical Position at Sea." Reprinted from the *United States Naval Institute Proceedings* for December, 1908.

NOTE.—This expression of opinion is made public by special permission of the Hon. Secretary of the Navy. O.N.I. No. 9864 of 1909.

BOOK NOTICES

Of the U.S. Naval Institute Proceedings, March, 1910

"ALTITUDE AND AZIMUTH TABLES," 1910. By Lieutenant Radler de Aquino, Brazilian Navy.

After a careful examination of this book and of the methods given for the solution of the astronomical triangle there can be no doubt of its practicability and of its claim, "The simplest and readiest in solution."

In the solution of the line of position for the sun, which is by far the most common of all sights, and employing all figures to get functions as closely as given in the Nautical Almanac, which in practice is not necessary, a comparison of the two methods is as follows :—

	Figures.	Book openings.	Time.
Common to both . . .	177	8	$9^m\ 30^s$
Peculiar to each . . .	101 Aquino	2	4^m
	138 St. Hilaire	9	$7^m\ 30^s$

Upon examination of the above table it can be immediately seen how much quicker in solution the Aquino is. In point of accuracy of results within the limits of 70 declination, and taking into consideration the errors of observation, there is no choice. There is less chance of making errors in working on account of the fact that only four functions have to be picked out accurately from the tables, whereas in the St. Hilaire eight have to be found. In comparing the two methods the part common to both is not considered.

In the case of the meridian altitudes the ordinary method of combining the zenith distance and declination is better than the method shown in this book, on account of it being necessary to remember one precept instead of four.

The method of finding latitude from a sight of Polaris presents no advantages over that given in the back of the Nautical Almanac for the current year, and has less advantage over that given in the Almanac of 1912.

The determination of the line of position without azimuths is to be commended and, if the altitude is to be determined by the tables of this book, is of great value.

The necessity of the rectification of lines of position occurs very rarely in practice, but when it does happen this method is an excellent one.

The identification of celestial bodies and the finding of the approximate altitude and azimuth before taking a sight are, under the present great interest in the use of stars for navigational purposes, of great value, and when the tables are once thoroughly understood, very easy to find.

Azimuths can be determined with ease and necessary accuracy by means of these tables.

The use of these to find the Great Circle Course is not recommended. Lunar distances have been abandoned by navigators.

Taken as a whole, this book cannot be too highly recommended, and all navigators should possess a copy. It is to be hoped that the author will publish the larger book he is making out for his own use.

G. R. MARVELL,

Commander, U.S. Navy, Head of the Department of Navigation.
U.S. Naval Academy, Annapolis.

INTRODUCTION

The determination of lines of position (from which geographical position—latitude and longitude—is deduced at sea), the identification of celestial bodies and the determination of distance and course in Great Circle Sailing are the three principal problems of Navigation depending upon the solution of a spherical triangle.

In each problem we have two sides and the included angle to find the third side and one of the other angles. This means that all the three problems can be solved in the same way, by the same formulæ, by the same method, and by the same tables.

Most of the problems of celestial Navigation depend upon the solution of a right-angled spherical triangle, and as the three principal problems are solved by dividing the spherical triangle into two right-angled triangles, they *all* may be easily and readily solved *without logarithms* by aid of the appended tables,[1] which, however, were especially arranged for facilitating the determination of lines of position and the identification of celestial bodies at sea.

The method used for determining lines of position is general, every sight is worked out the same way ; no special classification needs to be made before trying to work it out. Whether the sight is a circum-meridian, an ex-meridian, or a time-sight, it is always worked out the same way. At the same time, no signs or naming of auxiliary data comes in to confuse the navigator. The only calculations involved are two small multiplications (not always necessary), and the finding of C with L and b, by the use of simple formulæ, without giving consideration to algebraic signs or arcs greater than 90°.

The tables will also enable the navigator in latitudes above 45° to

[1] Besides these tables our volume contains tables for converting intervals of mean solar time into those of sidereal time (acceleration) ; for converting time into arc, and vice versa ; for the total correction of altitudes of Stars and Planets, the Sun and the Moon ; change of altitude per minute of arc of hour angle, change of azimuth per minute of arc of altitude; for controlling the coincidence of lines of position ; azimuths of *Polaris ;* change of altitude per minute of time, and for rectifying lines of position. Also Plane Traverse Tables, a Ready Reckoner, &c.

With the exception of the tables for rectifying lines of position, all the others are well known and need no explanation. In the tables for correcting altitudes, the corrections were calculated with data (mean refractions, mean dip of the horizon, parallax in altitude, &c.) tabulated in the *Connaissance des Temps*, published by the Bureau des Longitudes, Paris.

determine with great accuracy lines of position on Mercator's chart without azimuths.

Time-azimuths for compass correction and control are found without interpolation by the same method used for determining lines of position, which, of course, is a decided advantage.

Such questions as: Where are we? What star is that? &c., will receive a prompt and accurate reply when the problem is worked out by our methods and our tables.

Fortunately most of the problems do not require great approximation, and for this reason interpolations are practically unnecessary.

The omission of Lunar Distances from the *Nautical Almanac*, as "no longer of sufficient use to justify their retention," has forced upon navigators the necessity of knowing how to calculate them.

This problem is similar to the problem of determining *distance* in Great Circle Sailing, and we believe that from the sailor's point of view our method (and formulæ) will prove more satisfactory than the one given in the *Nautical Almanac*, because it does not involve the use of algebraic signs or arcs greater than 90°, always a cause of difficulty, confusion, and error.

Many valuable suggestions received from Dott. Giuseppe Pesci, of the Royal Italian Naval Academy, Livorno, Italy, have been embodied in this work, and it gives us great pleasure to acknowledge here our grateful thanks.

The author hopes that navigators will appreciate the great advantages these tables present. Indeed, we may safely say: They are "*the simplest and readiest in solution.*"

On board the Brazilian battleship *Minas Geraes*,
NEWCASTLE-UPON-TYNE,
November 11, 1909.

INTRODUCTION TO SECOND EDITION

The addition of the complementary column *c/C* reducing to a *minimum* the work of combining *L* and *b*, of a Plane Traverse Table for distances up to 300 miles, of a Ready Reckoner, of the Sun's upper Limb Correction Table, of the Table giving the change of hour angle per minute of arc of altitude and a most careful and complete revision of the tables and text represent the improvements and further simplifications to be found in this new edition. A new set of Tables for calculating the *Altitude* have been added for use of those people who do not like to use the *assumed position.* They are also "*the simplest and readiest in solution.*"

HYDROGRAPHIC OFFICE, RIO DE JANEIRO,
November 11, 1911.

CIRCLES, CURVES, AND LINES OF POSITION

A line of position is just as valuable as the isolated knowledge of latitude or longitude, and represents the exact and only true interpretation of a sight.

When a navigator at a given instant of Greenwich (known by a chronometer regulated to mean or sidereal time) observes the altitude of a celestial body, he determines *ipso facto* on the celestial sphere a small circle passing through his zenith.[1]

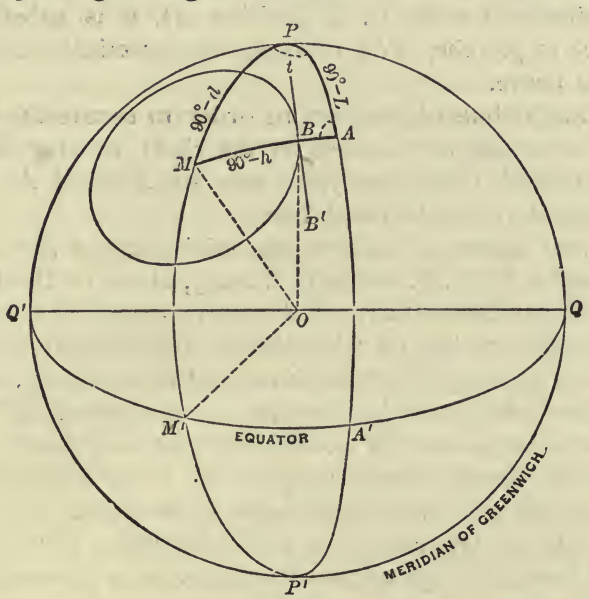

FIG. 1.

This circle is determined by its centre and its radius. The centre of the circle is *M*, the centre of the celestial body at the moment of the observation, and is determined by the declination *d* or *MM'* (sometimes called Geographical Latitude) of the body, and by its

[1] This discovery was first made by Captain THOMAS H. SUMNER, an American shipmaster, in 1837, and was explained on page 42 of his work, "A New and Accurate Method of Finding a Ship's Position at Sea, by Projection on Mercator's Chart," Boston, 1843.

Vide also BARTHET, "Méthode graphique pour faire le point à la mer," published in the *Annales maritimes et coloniales*, Paris, 1847, for an account of Captain Sumner's discovery.

hour angle from Greenwich, *QPM'* (called its Geographical Longitude). The radius is the body's true zenith distance, *MB* (the complement of its true altitude). With these elements we could, if practical, draw the circle on a globe. This circle is known as the *circle of position*, because it contains the navigator's zenith corresponding to his position on the surface of the Earth.

The transformation affecting all spherical figures when we pass from the terrestrial globe to Mercator's chart also involves the circle of position, which is transformed into a curve of position, open or closed, according to the position of the poles in relation to the circle.

In order to know his position, it is not necessary for the navigator to draw the whole curve on the chart, and, in view of the difficulty of even drawing a small portion of it in the vicinity of the observer (always indicated by the D. R. position *A*), it is substituted by a *straight line of position*, *BB'*, representing practically the necessary part of the curve.

This straight line of position, in order to secure the best results, ought to be always determined on the chart, or elsewhere, by the method invented thirty-five years ago by Admiral A. Blond de Marcq Saint-Hilaire,[1] French Navy.

"*The great advantage of this method of obtaining a line of position,*" as Commander W. C. P. Muir, U.S. Navy, Head of the Department of Navigation of the U.S. Naval Academy, explicitly states in italics in his excellent treatise on "Navigation and Compass Deviations,"[2] second edition, 1908, p. 640, "*lies in the fact, that since the formulæ make it available practically without limitations as to azimuth, altitude, or hour angle, it furnishes one method equally applicable to all conditions, whether these conditions would otherwise require the formulæ of a time-sight, a* $\phi''\phi'$ *sight, or that of a body observed near the meridian.*"

It consists in determining a particular point *B* (known as the "*computed point*") of the circle of position—the intersection of *AM*, the vertical circle of the celestial body passing through the D. R. position *A* with the circle of position. These two circles intersect each other at right-angles, and therefore the straight line of position will be also perpendicular to the body's true bearing.

Thus the determination of the line of position, *containing the observer's position*, consists in constructing a straight line drawn through the computed point *B* at right-angles to the body's true bearing.

In order to determine the computed point *B* when the position by D. R. *A* is given, we lay off from this point, as shown in Fig. 1, a

[1] *Vide* "Calcul du point observé," *Revue maritime et coloniale*, vol. xlvi., 1875, pages 341 and 714.

[2] Published by the United States Naval Institute, Annapolis, Md., U.S.A., price five dollars gold.

distance, *AB*, equal to the difference between the two zenith distances : the D. R. *AM*, and the *true BM* (or between the two altitudes: the *true* and the *D. R.* with opposite sign). The extremity of this length is the computed point *B*. This point is *always* nearer to the true position than the position by D. R., and represents the most probable position of the observer, when only one observation is available.

The difference between the two altitudes is called *altitude difference* or *intercept.*

The position by D. R. *A*, the altitude difference *AB*, and the body's azimuth *PAM* are the elements necessary and sufficient for determining a line of position at sea.

The position by D. R. is generally computed up to the time of observation, the true altitude is found by taking and correcting the observed altitude ; the calculated altitude and azimuth (from which the true bearing is found) are easily and rapidly determined by our tables as explained hereafter.

In order, however, to do away with interpolations and corrections which otherwise would have had to be made before finding the altitude and azimuth, we take an *assumed* latitude and longitude instead of the latitude and longitude by D. R.[1] Referring to Fig. 4 on page xxvi, we consider *A'* (the *assumed* position) instead of *A* (the position by D. R.) for determining the line of position.

The advantages of using an assumed position instead of the position by D. R. have not been fully appreciated by the majority of navigators. No greater accuracy is gained by determining the line of position from *A* than from *A'*, while the use of this position, as we will see further on, facilitates and reduces the computations very much, thus minimising the chances of error, &c.

Finally, the problem of determining a line of position at sea reduces itself to find how far (in miles) the line of position is from the ASSUMED *position, and in what direction it lies.*

[1] "A Navegação sem Logarithmos" (Navigation without Logarithms). *Imprensa Nacional.* Rio de Janeiro, 1903. Published by order of the Minister of Marine. This work was preceded by an article by the author in the *Revista Maritima Brazileira*, Oct. 1902. "Taboas para achar alturas e azimuths, etc." The present tables represent an enlarged, improved, and very simplified edition of "A Navegação sem Logarithmos." *Vide* also "Resolução Nomographica do Triangulo de Posição" by DOTT. G. PESCI. Translated from the Italian into Portuguese by the author of these tables and reprinted from the *Revista Maritima Brazileira*, Nov. and Dec. 1907, and Feb. 1908, and DOTT. PESCI'S recent "Studio critico" : Sulle "Tables for facilitating Sumner's Method at Sea," di Lord Kelvin, in the *Rivista Marittima* for January 1909, page 43.

GENERAL PRINCIPLE AND EQUATIONS

In Fig. 2, P is the elevated pole and PMZ is the astronomical triangle of position projected on the plane of the horizon.

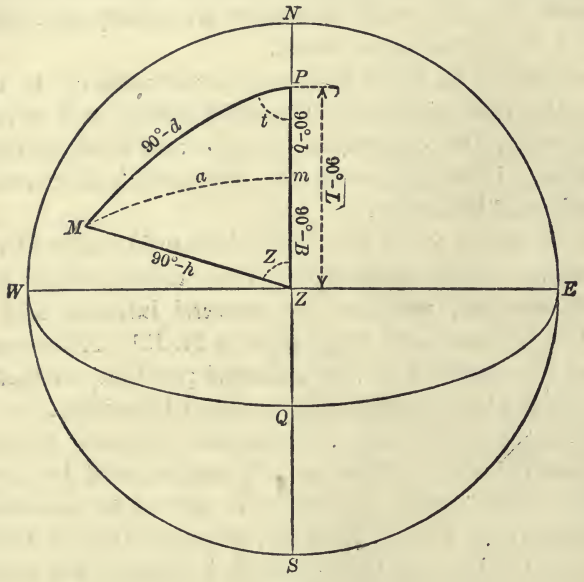

FIG. 2.

If we let fall a perpendicular from M on PZ, it will divide the triangle of position into two right-angled triangles.[1] Let us call the perpendicular a and the two parts into which PZ is divided $90°-b$ and $90°-B$.

The perpendicular a is common to the two triangles and therefore to

$$\begin{cases} a \text{ and } 90°-b \text{ in triangle } MPm \text{ correspond } 90°-d \text{ and } t \\ a \text{ „ } 90°-B \text{ „ „ } MZm \text{ „ } 90°-h \text{ „ } Z \end{cases}$$

and vice versa, or to

$$a \text{ and } \begin{cases} b \text{ correspond } d \text{ and } t, \\ B \text{ „ } h \text{ „ } Z \end{cases}$$

and vice versa.

---

[1] The principle upon which these tables are based is as old as Spherical Trigonometry itself, and naturally it was the only way of solving spherical triangles until, as DOTT. PESCI informs us, ALBATANI (880–928 A.D.) discovered the well-known relation (erroneously attributed to Euler) between the three sides and an angle of a spherical triangle

$$\cos a = \cos b \cos c + \sin b \sin c \cos A.$$

This correspondence is fundamental and must always be remembered.

By Napier's mnemonical rules we find the following equations binding together these elements:

$$(1)\ \begin{cases}\sin d = \cos a \sin b\\ \sin h = \cos a \sin B\end{cases} \qquad (2)\ \begin{cases}\cot t = \cot a \cos b\\ \cot Z = \cot a \cos B\end{cases}$$

and

$$(3)\ \begin{cases}\sin a = \cos d \sin t\\ \sin a = \cos h \sin Z\end{cases} \qquad (4)\ \begin{cases}\cot b = \cot d \cos t\\ \cot B = \cot h \cos Z\end{cases}$$

CONSTRUCTION OF THE TABLES

As a, b and B in groups of equations (1) and (2) can have values between 0° and 90°, we have tabulated the values of d and t corresponding to various values of a for every 30′ from 0° to 84° and for every 1° from 84° to 90° (88° 50′ being especially included on account of *Polaris*) and b for every 1° (and *ipso facto* the values of h and Z corresponding to various values of a and B).

As groups of equations (3) and (4) are respectively similar to (1) and (2), we notice that we have also tabulated the values of a and b corresponding to various values of d and t (and *ipso facto* the values of a and B corresponding to various values of h and Z).

For this reason the tables have two entrances.

The upper one with a and b as arguments giving, by means of the upper equations of groups of equations (1) and (2), d and t (or with a and B as arguments giving, by means of the lower equations of groups (1) and (2), h and Z).

The lower one with d and t as arguments giving, by means of the upper equations of groups of equations (3) and (4), a and b (or with h and Z as arguments giving, by means of the lower equations of groups (3) and (4), a and B, but not considered for greater simplicity in dealing with the principal problem).

For convenience and greater simplicity a complementary column c/C to column b/B is given on each page where c stands for $90°-b$ and C for $90°-B$.

Therefore the tables can also be entered with a and c giving d and t, and also with a and C giving h and Z.

Example I. Entering the tables on page 119 with $a=48°\ 0'$ and $b=59°$ we find $d=35°\ 0'$ and $t=65°\ 7'$.

Example II. Entering the tables on page 63 with $a=6°\ 0'$ and $B=73°$ or $C=17°$, we find $h=72°\ 0'$ and $Z=19°\ 46'$.

Example III. Entering the tables on page 91 with $d=27°\ 0'$ and $t=60°$ we find $a=50°\ 30'$ and $b=45°\ 32'$.

In columns $\frac{60'}{\Delta}$ and $\frac{\Delta}{60'}$, Δ represents the difference between two

successive values and the factors $\frac{60'}{\Delta}$ and $\frac{\Delta}{60'}$ are given in order to facilitate interpolation.

All values designedly appear in our tables,[1] and examples always reduced to the first quadrant with sign *plus* with further simplification in view.

CALLET'S[2] logarithms with *seven* decimal places were used in the calculations. In many cases VLACQ'S[3] *ten* decimal place logarithms were used.

EXAMINATION OF THE TABLES

A mere inspection of the tables shows at a glance how the elements vary in the astronomical triangle of position.

For a given value of *a*, *d* and *t* vary *proportionately* to *b* throughout the tables, except in a *very few practical cases when the declination of the observed body d is higher than* 70°.[4] As long as the difference $\left(\frac{\Delta_2}{60'}\right)$ between two successive values of $\frac{\Delta}{60'}$ is equal to or smaller than 0.15, the *maximum* error in *t* due to second differences is equal to or smaller than 1′. Up to $d=60°$ this *maximum* error is equal to or smaller than 0′.5.

Careful examination, however, of these *Tables* has shown that the error of *t* when using *simple interpolation* for *any* declination has no practical effect upon the value of *h* determined by them.

---

[1] These tables were first described by the author in the *United States Naval Institute Proceedings* for December 1908, page 1299, and in the *Revista Maritima Brazileira* for March 1909, page 1577. A description of them by DOTT. A. ALESSIO, R.I.N., is also found in the *Rivista Marittima* for March 1909, Appendice, page 56.

[2] "Tables de logarithmes, suivies d'un recueil de Tables nautiques." Editeur Firmin-Didot et Cie, Paris, 1883.

[3] "Trigonometria Artificialis sive Magnus Canon Triangulorum Logarithmicus," Gouda, 1633.

[4] The only relatively important star above 70° declination is β Ursæ Minoris with N 74° 31′ decreasing. Its magnitude is 2.2. Among the 316 stars above magnitude 4.1 (not including *Polaris*) catalogued in the *Nautical Almanac* for the year 1910, the highest declination is that of β Hydri, magnitude 2.9, with S 77° 46′ decreasing, and for this reason the differences $\frac{\Delta}{60'}$ only extend to this value of *d*. Of the 316 stars mentioned above there are only 6 with declinations higher than 70°, and 4 of them are below magnitude 3.0. Of the 486 stars catalogued in the *Nautical Almanac* for 1910 only 24 have higher declinations than 77° 46′, and their magnitudes range between 4.3 and 8.4, being therefore unsuitable for navigation.

It is noticed that the influence of the second differences only begins to appear in a *few* cases above the extreme limit of declination (=60°) adopted by *nearly all* nautical tables, notwithstanding the existence of 36 stars (15 of which are of or above 3.0) above magnitude 4.1, with greater declinations than 60°.

ALTITUDE AND AZIMUTH FOR LINES OF POSITION

The problem is : Given d, t and L, find h and Z.

Determination of h and Z.

Let us see now how altitude and azimuth can be easily and rapidly determined by these tables.

Entering the tables with d and t as arguments, we will find in columns a and b approximate values of a and b.

Entering the tables again with a and b as arguments, we will find approximately the values of d and t given.[1] The true value of b is then determined for the *exact* value of d and a value of t is found corresponding to this b.

The values of h and Z will then be found in the same column a corresponding to B or to its complement C.

Example. $d=16^\circ\ 27'$, $t=61^\circ\ 10'$ and $L=23^\circ\ 39'.3$.

Entering the tables with $d=16^\circ\ 30'$ and $t=61^\circ$ we find $a=57^\circ\ 0'$ and $b=31^\circ\ 26'$. Corresponding to $a=57^\circ\ 0'$ and $b=31^\circ$ we find $d=16^\circ\ 17'$ and $t=60^\circ\ 54'$. The true value of b corresponding to $d=16^\circ\ 27'$ is $31^\circ\ 20'.7$ and the value of t corresponding to this value of b is $60^\circ\ 59'.6$.

If $B=35^\circ$ (or $C=55^\circ$) we will have $h=18^\circ\ 12'$ and $Z=61^\circ\ 59'$.

Determination of C.

We will now show how C is determined when L and b are known.

When the perpendicular a falls between P and Z, as it does in Fig. 2 (d and L being of the *same name* and $t<90^\circ$), we have

$$[90^\circ-B]+90^\circ-b=90^\circ-L$$

and therefore

$$C=b-L \ : \text{ when } L<b.$$

If the perpendicular fell between Z and Q (d and L being also of the *same name* and $t<90^\circ$), we would have

$$[90^\circ-B]+90^\circ-L=90^\circ-b$$

and therefore

$$C=L-b \ : \text{ when } L>b.$$

---

[1] The value of a shows *immediately* on which two pages of the tables we have to work, and also in which of the three columns. The value of b shows on which of the two pages we have to begin, and also the line on which the approximate values of d and t are found. Although *not strictly necessary* this knowledge of the approximate value of b is convenient.

The value of a is *also not strictly necessary* as long as the values of d and t are found together in the same column a. After a little manipulation of the tables no difficulty will be experienced in finding them together in the same column a.

In case the perpendicular fell between P and N (which only happens when $t>90°$ and we enter the tables with $180°-t$ instead of t), we would have

$$[90°-B]=90°-L+90°-b$$

and therefore

$$C=180°-(L+b).$$

Finally, when the perpendicular falls between Q and S (d and L are then of *contrary names*), we have

$$[90°-B]+90°-L=90°+b$$

$$C=L+b.$$

Thus when

$$\left.\begin{array}{l} d \text{ and } L \text{ same name} \left\{\begin{array}{l} t<90° \left\{\begin{array}{l} L<b : C=b-L;\ Z<90° \\ L>b : C=L-b;\ Z>90° \end{array}\right. \\ t>90° \ldots\ldots : C=L+b;\ Z<90° \end{array}\right. \\ d \text{ and } L \text{ contrary names} \ldots\ldots : C=L+b;\ Z>90° \end{array}\right.$$

By these formulæ C can be obtained from L and b with great simplicity and rapidity.

In the first two cases, the *smaller* of the two quantities L and b, is always subtracted from the *larger* of the two.

In the third and fourth cases L and b are *always* added together. When $t>90°$ their sum is always greater than 90°, and it is subtracted from 180°. When d and L are of contrary names their sum is always smaller than 90°.

The quadrant in which the observed body is, is also shown for reference and by our method is *always* known *a priori*.

When d and L are of the same name and $t<90°$, Z is *less* or *greater* than 90° when L is *less* or *greater* than b.

When $t>90°$, Z is *always less* than 90° ; finally when d and L are of contrary names Z is *always greater* than 90°.

When $Z<90°$ the value of Z given by the tables is reckoned from the *elevated* pole to East or West, and when $Z>90°$ from the *depressed* pole to East or West, since the tables only give values up to 90°.

Variations of Data.

A further inspection of the Tables shows that they are also available for determining at sight by inspection "what effect given variations of data will produce in quantities computed from them."[1]

If we call Δh, ΔZ, Δd, Δt, and ΔL respectively the variations of altitude, azimuth, declination, hour angle and latitude the following formulæ will give us the errors Δh and ΔZ in the values of h and Z

computed, when d, t and L are affected by small errors Δd, Δt and ΔL respectively :—

$$\Delta h = \cos M\, \Delta d - \cos L \sin Z\, \Delta t + \cos Z\, \Delta L \qquad (1)$$

and

$$\cos h\, \Delta Z = \sin M\, \Delta d + \cos M \cos d\, \Delta t - \sin h \sin Z\, \Delta L \qquad (2)$$

where M is the parallactic angle.

Changes of Altitude and Azimuth.

If Δd and ΔL are *nil* we have by (1) $\Delta h = -\cos L \sin Z\, \Delta t$, or $\frac{\Delta h}{\Delta t} = -\cos L \sin Z$, which gives us the "Change of Altitude per Minute of Arc of Hour Angle" (Table on p. 170).

If Δt and ΔL are *nil* we have by (1) $\Delta h = \cos M\, \Delta d$, or $\frac{\Delta h}{\Delta d} = \cos M$, which gives us the "Change of Altitude per Minute of Arc of Declination."

If Δd and Δt are *nil* we have by (1) $\Delta h = \cos Z\, \Delta L$, or $\frac{\Delta h}{\Delta L} = \cos Z$, which gives us the "Change of Altitude per Minute of Arc of Latitude."

In the same way we would have by (2)

$\Delta Z = \cos M \cos d \sec h\, \Delta t$, or $\frac{\Delta Z}{\Delta t} = \cos M \cos d \sec h$

$\Delta Z = \tan h \sin Z\, \Delta L$ „ $\frac{\Delta Z}{\Delta L} = \tan h \sin Z$

$\Delta Z = \sin M \sec h\, \Delta d$ „ $\frac{\Delta Z}{\Delta d} = \sin M \sec h$

The 1st expression of ΔZ is easily transformed into

$$\Delta Z = \sin L\, \Delta t - \tan h \cot Z\, \Delta h$$

as explained on page xxvii later on.

The value of ΔZ from the 2nd expression of ΔZ is given immediately by the Tables in column $\frac{\Delta}{60'}$ alongside the value of Z.

Example. If $h = 38°$ and $Z = 62°$ we will find them approximately together in column $a = 44°$ on page 113, and therefore $\frac{\Delta Z}{\Delta L} = 0'.70$ found in column $\frac{\Delta}{60'}$ alongside Z $(= 61° 56')$.

The 3rd expression of ΔZ has not any practical importance, as Δd is always smaller than $0'.5$.

---

[1] and [2] CHAUVENET, "A Manual of Spherical and Practical Astronomy," Philadelphia, 1890. Vol. I. pp. 50, 51.

The Parallactic Angle M.

By interchanging L and d in the tables we can find immediately in column Z the parallactic angle M.

The Longitude Factor, or Pagel's Coefficient.

If Δh and Δd in (1) are *nil* we can find immediately the longitude factor or Pagel's coefficient the most important of all, as it shows at once the change of hour angle or longitude due to a change of 1′ in the latitude.

We find from (1) when $\Delta h = \Delta d = 0$

$$\cos L \sin Z \Delta t = \cos Z \Delta L$$

or

$$\cos L \cdot \frac{\Delta t}{\Delta L} = \cot Z$$

In our Tables

$$\cos B \cot a = \cot Z$$

and, therefore, if we enter the Tables with L in the place of B and Z in column Z, the cotangent of a in which Z stands is equal to $\frac{\Delta t}{\Delta L}$, the longitude factor, or Pagel's coefficient.

The blackfaced numbers at the head of each four columns represent the cot a above which they are.

I. *Example.* If $L = 24°$ and $Z = 73°\ 0'$ we will find on page 148

$$\frac{\Delta t}{\Delta L} = \cot a = \cot 71°\ 30' = 0'.335.$$

II. *Example.* If $L = 55°$ and $Z = 60°\ 10'$ we will find on page 115

$$\frac{\Delta t}{\Delta L} = \cot a = \cot 45° = 1'.000.$$

III. *Example.* If $L = 50°$ and $Z = 42°\ 30'$ we will find on page 95

$$\frac{\Delta t}{\Delta L} = \cot a = \cot 30°\ 30' = 1'.698.$$

For the sake of simplicity we will call $\frac{\Delta t}{\Delta L} : p$.

Latitude Factor.

The latitude factor or the change of latitude due to a change of 1′ in the hour angle or longitude is found immediately by noticing that $\frac{\Delta L}{\Delta t}$ is the reciprocal of $\frac{\Delta t}{\Delta L}$ or of cot a, that is, cot $(90° - a)$ or tan a.

I. *Example.* If $L = 24°$ and $Z = 73°\ 0'$ we will find on page 81

$$\frac{\Delta L}{\Delta t} = \tan a = \cot 19°\ 30' = 2'.824.$$

II. *Example.* If $L = 55°$ and $Z = 60°\ 10'$ we will find on page 115

$$\frac{\Delta L}{\Delta t} = \tan a = \cot 45°\ 0' = 1'.000.$$

III. *Example.* If $L = 50°$ and $Z = 42°\ 30'$ we will find on page 133

$$\frac{\Delta L}{\Delta t} = \tan a = \cot 59°\ 30' = 0'.589.$$

I. TYPICAL EXAMPLE FOR *ALL* SIGHTS

(Whether circummeridian, ex-meridian or time sights.)

The following typical example is given in order to illustrate the way in which *all* sights ought to be treated:

Sight of the Sun.

On February 21, 1910, about 8^h A.M., in Lat. by D. R. 36° 56′ N.,[1] and Long. by D. R. 8° 5′ W., the observed altitude of the Sun's lower limb, bearing southward and eastward, was 20° 59′.2 at $21^h\ 6^m\ 11^s$ of the chronometer, $6^m\ 59^s$ slow of G. M. T. Height of eye 36 ft. Required the line of position.

C. $= 21^h\ 6^m\ 11^s$
C.C. $= +\ 6\ 59$
G. M. T. $= 21^h\ 13^m\ 10^s$
Eq. of T. $= -\ 13\ 46$
$a = 52°\ 0'$ G. A. T. $= 20^h\ 59^m\ 24^s$ or $t_G = 3^h\ 0^m\ 36^s$ E $= 45°\ 9'.0$ E

$b = 17°\ 8'.4$ $d = 10°\ 27'$ S $t_A = 53\ 15.3$ E

$L_A = 36\ 51.6$ N $G_A = 8°\ 6'.3$ W

$h_o = 20°\ 59'.2$
Corr. $= +\ 7.8$
$h = 21°\ 7'.0$

$C = 54°$ $h_A = 21\ 13.0$ $Z_A = $ S 57° 42′ E

$h - h_A = -\ 6'.0$

Note. This calculation could have been made in advance before taking the sight if it had been decided to observe the Sun at $21^h\ 6^m\ 11^s$ of the chronometer.

Working out this example with 5 decimal place logarithms we would find, with $d = 10°\ 27'$, $t_A = 53°\ 15'.3$ and $L_A = 36°\ 51'.6$:

$$b = 17°\ 8'.0,\ h_A = 21°\ 13'.1 \text{ and } Z_A = 57°\ 42'.4$$

by means of groups of equations: (2) for Z and (4) for b and h.

---

[1] As in practice an *assumed* latitude is used instead of the latitude by D. R., it is better, in order to avoid mistakes, not to consider the latitude by D. R. at all, only the longitude by D. R., except when only one observation is available and the ship's most probable position has to be found. The longitude by D. R., itself is only used to find the approximate value of a.

When due to unknown currents or any other reason we have not a reliable D. R. position, a can be determined by means of h and Z. Z is found by compass observation or by the method indicated on page xxxv. Enter the tables with h in the place of d and Z in the place of t.

Group (3) constitutes the *check* group, because it contains d and t given, and h and Z required.

log tan d=9.26585		
log sec t=0.22311	log tan t=0.12691	
log tan b=9.48896	log cos b=9.98029	
b=17° 8′.0	log cosec C=0.09208	log tan C=0.13863
L=36° 51′.6	log tan Z=0.19928	log sec Z=0.27225
		log cot h=0.41088
C=53° 59′.6	Z=57° 42′.4	h=21° 13′.1

log cos d=9.99274	log cos h=9.96951
log sin t=9.90379	log sin Z=9.92702
log sin a=9.89653	log sin a=9.89653
a=52° 0′	a=52° 0′

This development shows the time and trouble our tables save, besides doing away with the turning of pages, lessening the chances of error, and simultaneously checking, *per se*, part of the results. In these calculations advantage has been taken of our precepts, and therefore no algebraic signs or arcs greater than 90° appear.

Explanation.

After the correction is applied to the chronometer time and the equation of time to the G. M. T. we fibd G. A. T. also called the "Sun's geographical longitude" (⊙'s $t_{G.}$), because it is the Sun's hour angle from Greenwich. This G. A. T. is *immediately converted into arc*[1] and combined apart with the Longitude by D. R. or $G_{D.R.}$, giving the Sun's hour angle from D. R. or $t_{D.R.}$ in *arc*:

⊙'s $t_{G.}$=	45° 9′ E
$G_{D.R.}$=	8 5 W
⊙'s $t_{D.R.}$=	53° 14′ E

The declination of the Sun, found in the *Nautical Almanac* at the same time as the Eq. of T., is taken to the nearest minute of arc. (It is noticed that no seconds of arc are used in our method nor are they necessary, and the quantities expressed in arc need only be taken within *one-tenth of one minute* when greater accuracy is desired).

Entering the tables on page 69 with d=10° 30′ and $t_{D.R.}$=53° 14′ as arguments, we find in column a: 52°, which is an approximate value of a, and in column b: 17°, which is an approximate value of b.

Entering the tables again on page 122 with a=52° 0′ and b=17° as arguments, we find that the Sun's declination 10° 27′ is comprised between 10° 22′ and 10° 58′ respectively corresponding to b=17° and

[1] This procedure, not usually followed in the text books, has the *triple* advantage of simplifying the determination of t, abolishing the argument in time in the tables and the necessity of dealing with data expressed in time and in arc after G. A. T. is converted.

$b=18°$. Interpolating (here the interpolation is reduced to the multiplication of the factor $\frac{60'}{\Delta}=1.67$, by the difference between 10° 27′ and 10° 22′, that is 5′), we find that $b=17°\ 8'.4$ and $t_{A.}$ corresponding to this value of b is 53° 15′.3. The ready reckoner on pp. 50 to 53 will save the trouble of doing these multiplications.

In order to do away with any corrections, this $t_{A.}$, which differs from $t_{D.R.}$ *one minute and three-tenths*, is taken as the hour angle. Combining it with the ⊙'s $t_{G.}=45°\ 9'.0$ W., we find a longitude which may be called *assumed:* $G_{A.}=8°\ 6'.3$ W.

In order to do away with any further interpolations, C is made a whole number of degrees by *assuming* a latitude, nearly the same as the Lat. by D. R., that will make it so. In our particular case it will be seen that $L_{A.}=36°\ 51'.6$ combined with $b=17°\ 8'.4$, according to the precepts given, d and L contrary names: $C=L+b$; $Z>90°$, will make C just 54°.

Therefore in the same column $a=52°\ 0'$ with $C=54°$, we will find $h_{A.}=21°\ 13'$ and $Z_{A.}=57°\ 42'$.

Check.

The necessary calculations to find $h_{A.}$ and $Z_{A.}$ are so simple and few, and, therefore, the liability to error so small, that we do not think a check is necessary.

However, the correctness of the calculations might be tested *without new data* by proceeding backwards, as explained further on for "identifying celestial bodies" (*vide* page xxxv).

To $h_{A.}=21°\ 13'$ and $Z_{A.}=57°\ 42'$ corresponds $B=36°$ in column $a=52°\ 0'$. If $L_{A.}=36°\ 51'.6$, c will be found by the precepts on page xxxvi. As $Z>90°$, $c=L_{A.}+B=72°\ 51'.6<90°$, b will be 17° 8′.4, and we will find by interpolation (here it is reduced to the division of 8′.4 by the factor $\frac{60'}{\Delta}=1.67$ giving 5′) $d=10°\ 27'$ and $t_{A.}=53°\ 15'.3$, "d and L contrary names" and "$t<90°$".

Of course, if d and $t_{A.}$ were not the same as used before, the calculations would be in error.

Plotting the Line of Position.

Fig. 3, representing a section of a chart of the coast of Portugal, shows A the *assumed* position from which the line of position is determined. The *altitude difference* is $AB=-6'.0$. It is + when the true altitude h is *greater* than the assumed altitude $h_{A.}$ and − when the true altitude is *smaller* than the assumed altitude. It is always taken in the direction of the observed body; *towards*, when + and in the opposite direction; *away from*, when −.

LG is the line of position perpendicular to AB. The foot of

the perpendicular dropped from the position by D. R. on the line of position is the ship's most probable position and *must* be taken as the ship's position when only one observation is available.

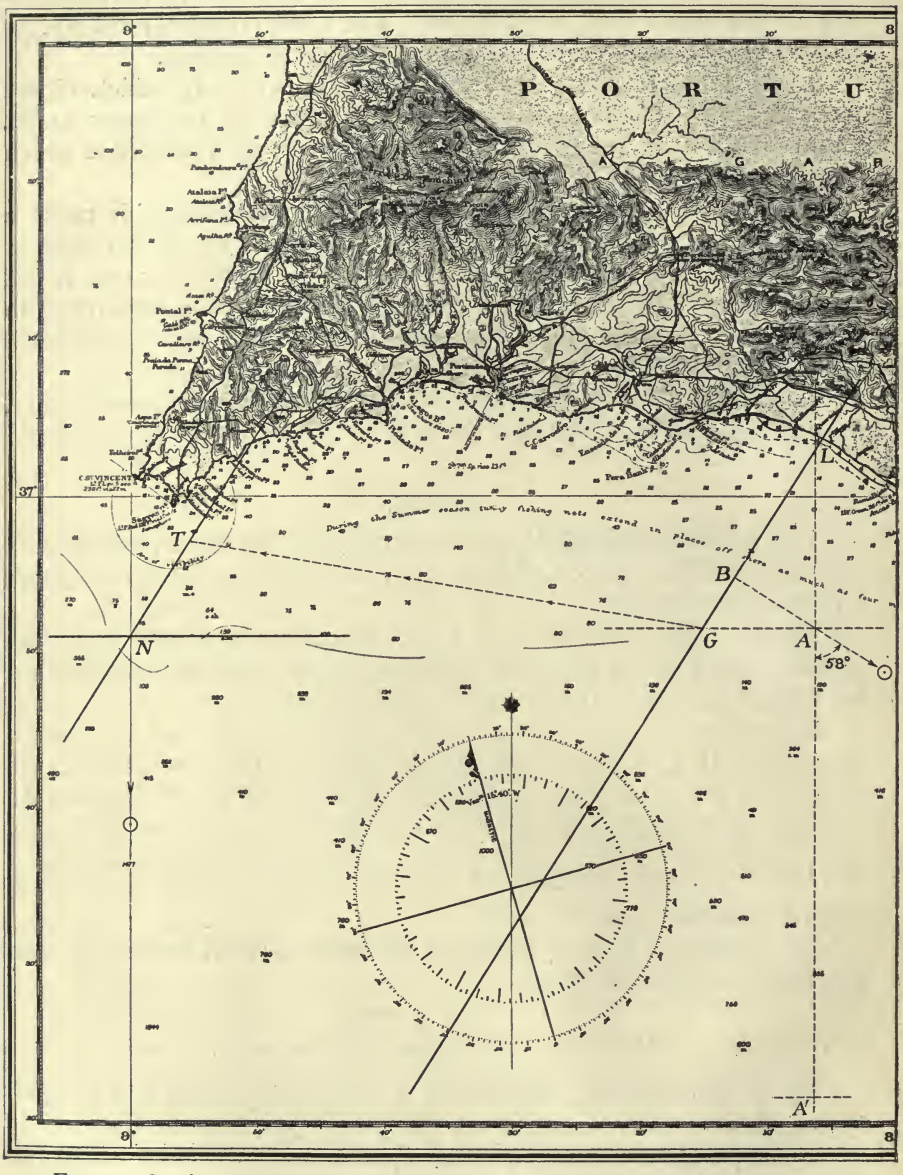

FIG. 3.—Section of a chart of the coast of Portugal showing how line of position is plotted and ship's position AT NOON is found.

This line of position is just as valuable as the isolated knowledge of latitude or longitude, and represents the exact and only true interpretation of the sight.

II. TYPICAL EXAMPLE FOR *ALL* SIGHTS

The following typical example is also given in order to illustrate the way in which *all* sights ought to be treated:

Sight of the Sun.

On August 21, 1908, about 11^h A.M., in Lat. by D. R. 16° 16′ S.,[1] and Long. by D. R. 38° 18′ W., the observed altitude of the Sun's lower limb, bearing northward and eastward, was 59° 0′ at $1^h\ 19^m\ 40^s$ of the chronometer, $26^m\ 59^s$ slow of G. M. T. Height of eye 28 ft. Required the line of position and the ship's most probable position.

C. = $1^h\ 19^m\ 40^s$
C. C. = + 26 59
G. M. T. = $1^h\ 46^m\ 39^s$
Eq. of T. = − 3 3
G. A. T. = $1^h\ 43^m\ 36^s$ or $t_{G.} = 25°\ 54'$ W

$a = 12°\ 0'$
$b = 12°\ 26'.5$
$L_{A.} = 16\ 33.5$ S

$d = 12°\ 10'$ N

$t_{A.} = 12\ 17$ E
$G_{A.} = 38°\ 11'$ W

$h_o = 59°\ 0'$
Corr. = + 10
$h = 59°\ 10'$
$h_{A.} = 58\ 49$
$h - h_{A.} = + 21'$

$C = 29°$

$Z_{A.} = $ N 23° 41′ E

Note. This calculation could have been made in advance before taking the sight if it had been decided to observe the Sun at $1^h\ 19^m\ 40^s$ of the chronometer.

Working out this example with 5 decimal place logarithms we would find, with $d = 12°\ 10'$, $t_{A.} = 12°\ 17'$ and $L_{A.} = 16°\ 33'.5$:

$$b = 12°\ 26'.6,\ h_{A.} = 58°\ 48'.8 \text{ and } Z_{A.} = 23°\ 40'.8$$

by means of groups of equations: (2) for Z and (4) for b and h.

---

[1] As in practice an *assumed* latitude is used instead of the latitude by D. R., it is better, in order to avoid mistakes, not to consider the latitude by D. R. at all, only the longitude by D. R., except when only one observation is available and the ship's most probable position has to be found. The longitude by D. R., itself is only used to find the approximate value of a.

When due to unknown currents or any other reason we have not a reliable D.R. position, a can be determined by means of h and Z. Z is found by compass observation or by the method indicated on page xxxv. Enter the tables with h in the place of d and Z in the place of t.

Group (3) constitutes the *check* group, because it contains d and t given, and h and Z required.

$\log \tan d = 9.33365$
$\log \sec t = 0.01006$
$\log \tan b = 9.34371$
$b = 12^\circ\ 26'.6$
$L = 16\ \ 33\cdot5$

$C = 29^\circ\ \ 0'.1$

$\log \tan t = 9.33792$
$\log \cos b = 9.98968$
$\log \operatorname{cosec} C = 0.31441$
$\log \tan Z = 9.64201$

$Z = 23^\circ\ 40'.8$

$\log \tan C = 9.74378$
$\log \sec Z = 0.03820$
$\log \cot h = 9.78198$

$h = 58^\circ\ 48'.8$

$\log \cos d = 9.99013$
$\log \sin t = 9.32786$
$\log \sin a = 9.31799$
$a = 12^\circ\ 0'$

$\log \cos h = 9.71418$
$\log \sin Z = 9.60381$
$\log \sin a = 9.31799$
$a = 12^\circ\ 0'$

This development shows the time and trouble our tables save, besides doing away with the turning of pages, lessening the chances of error, and simultaneously checking, *per se*, part of the results. In these calculations advantage has been taken of our precepts, and therefore no algebraic signs or arcs greater than 90° appear.

Explanation.

After the correction is applied to the chronometer time and the equation of time to the G. M. T. we find G. A. T. also called the "Sun's geographical longitude" ($\odot$'s $t_{G.}$), because it is the Sun's hour angle from Greenwich. This G. A. T. is *immediately converted into arc*[1] and combined apart with the Long. by D. R., giving the Sun's hour angle from D. R. or $t_{D.R.}$ in *arc*:

$\odot$'s $t_{G.} = 25^\circ\ 54'$ W
$G_{D.R.} = 38\ \ 18$ W
$\odot$'s $t_{D.R.} = 12^\circ\ 24'$ E

The declination of the Sun, found in the *Nautical Almanac* at the same time as the Eq. of T., is taken to the nearest minute of arc. (It is noticed that no seconds of arc are used in our method nor are they necessary, and the quantities expressed in arc need only be taken within *one-tenth of one minute* when greater accuracy is desired).

Entering the tables with $d = 12^\circ\ 0'$ and $t_{D.R.} = 12^\circ\ 24'$ as arguments, we find in column a: 12°, which is an approximate value of a, and in column b: 12°, which is an approximate value of b.

Entering the tables again with $a = 12^\circ\ 0'$[2] and $b = 12^\circ$ as arguments,

[1] This procedure, not usually followed in the text books, has the *triple* advantage of simplifying the determination of t, abolishing the argument in time in the tables and the necessity of dealing with data expressed in time and in arc after G. A. T. is converted.

[2] In this particular case by coincidence a is approximately the same as d.

we find that the Sun's declination 12° 10′ is comprised between 11° 44′ and 12° 43′ respectively corresponding to $b=12°$ and $b=13°$. Interpolating (here the interpolation is reduced to the multiplication of the factor $\frac{60'}{\Delta}=1.02$, by the difference between 12° 10′ and 11° 44′, that is 26′), we find that $b=12°\ 26'.5$ and $t_{A.}$ corresponding to this value of b is 12° 17′ (exactly 12° 17′.3). The ready reckoner on pp. 50 to 53 will save the trouble of doing these multiplications.

In order to do away with any corrections, this $t_{A.}$, which differs from $t_{D.R.}$ *seven minutes*, is taken as the hour angle. Combining it with the ⊙'s $t_{G.}=25°\ 54'$ W., we find a longitude which may be called *assumed*: $G_{A.}=38°\ 11'$ W.

In order to do away with any further interpolations, C is made a whole number of degrees by *assuming* a latitude, nearly the same as the Lat. by D. R., that will make it so. In our particular case it will be seen that $L_{A.}=16°\ 33'.5$ combined with $b=12°\ 26'.5$, according to the precepts given, d and L contrary names: $C=L+b$; $Z>90°$, will make C just 29°.

Therefore in the same column $a=12°\ 0'$ with $C=29°$, we will find $h_{A.}=58°\ 49'$ and $Z_{A.}=23°\ 41'$.

Check.

The necessary calculations to find $h_{A.}$ and $Z_{A.}$ are so simple and few, and, therefore, the liability to error so small, that we do not think a check is necessary.

However, the correctness of the calculations might be tested *without new data* by proceeding backwards, as explained further on for "identifying celestial bodies" (*vide* page xxxv).

To $h_{A.}=58°\ 49'$ and $Z_{A.}=23°\ 41'$ corresponds $B=61°$ in column $a=12°\ 0'$. If $L_{A.}=16°\ 33'.5$, c will be found by the precepts on page xxxvi. As $Z>90°$, $c=L_{A.}+B=77°\ 33'.5<90°$, and we will find by interpolation (here it is reduced to the division of 33′.5 by the factor $\frac{60'}{\Delta}=1.02$ giving 33′) $d=12°\ 10'$ and $t_{A.}=12°\ 17'$, "d and L contrary names" and "$t<90°$".

Of course, if d and $t_{A.}$ were not the same as used before, the calculations would be in error.

Plotting the Line of Position.

Fig. 4, representing a section of a chart of the coast of Brazil, shows A the position by D. R. and A' the *assumed* position from which the line of position is determined. The *altitude difference* is $A'B'=+21'$. It is + when the true altitude h is *greater* than the

assumed altitude h_A, and − when the true altitude is *smaller* than the assumed altitude. It is always taken in the direction of the observed body: *towards*, when + and in the opposite direction: *away from*, when −.

$B'B''$ is the line of position perpendicular to $A'B'$. B the foot of

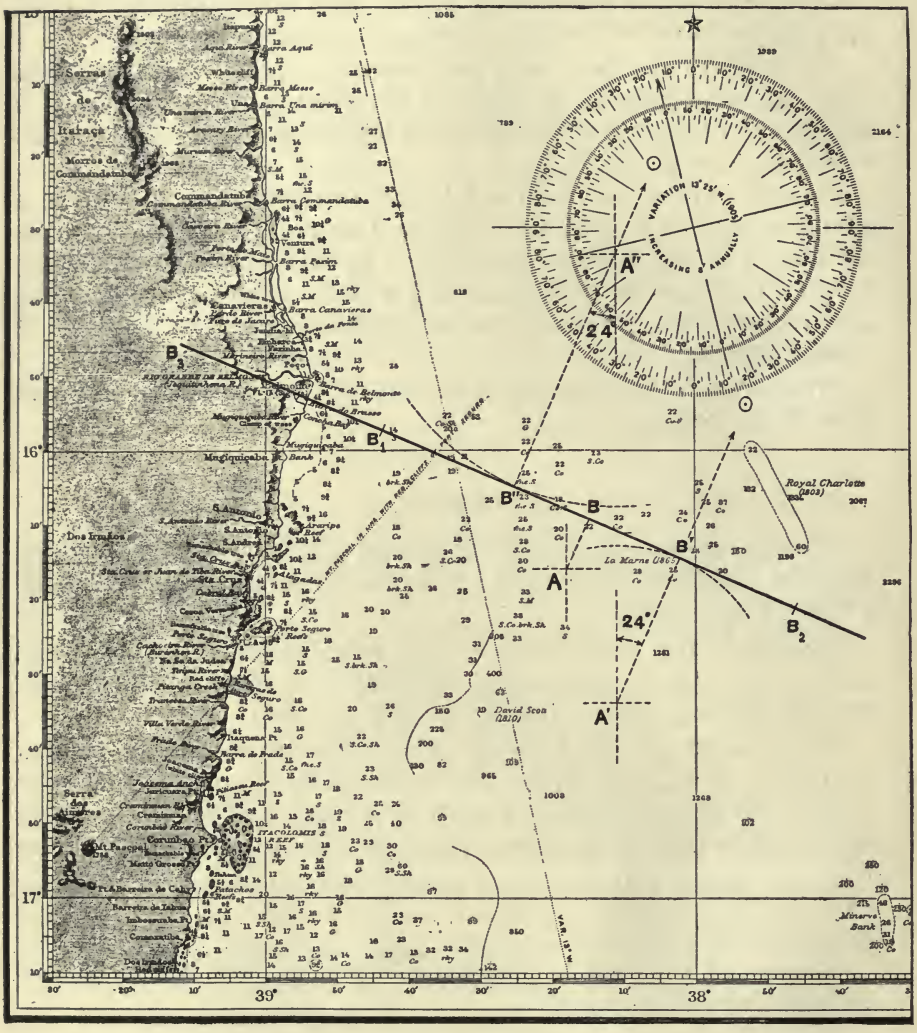

FIG. 4.—Section of a chart of the coast of Brazil showing how line of position is plotted and ship's most probable position found.

the perpendicular dropped from the position by D. R. on the line of position is the ship's most probable position and *must* be taken as the ship's position when only one observation is available.

This line of position is just as valuable as the isolated knowledge of

latitude or longitude, and represents the exact and only true interpretation of the sight.[1]

Altitude and Azimuth from D. R. Position.

When the observer wishes to find $h_{D.R.}$ and $Z_{D.R.}$ corresponding to the position by D. R., instead of taking an assumed position A' (or A'') (and this might be desirable when $t_{D.R.}-t_{A.}$ is large, when the *altitude difference* is greater than the established limits on page xxxii, or when 2, 3, and 4 lines of position have to be plotted simultaneously), it is necessary for him to find :

1st. The value of C with $L_{D.R.}$ and b according to the same precepts given on page xvi and by simple interpolation the corresponding values of h' and Z' (approximate values of $h_{D.R.}$ and $Z_{D.R.}$) ;

2nd. The corrections Δh and ΔZ to be applied to these values h' and Z' given by the tables due to the difference $t_{D.R.}-t_{A.}=\Delta t$.

These corrections are given by the following formulæ[2] :

$$\Delta h = \mp \cos L \sin Z' \Delta t \quad \text{or} \quad \frac{\Delta h}{\Delta t} = \mp \cos L \sin Z'$$

and

$$\Delta Z = \Delta_1 Z + \Delta_2 Z$$

where

$$\Delta_1 Z = \mp \sin L \, \Delta t \qquad \text{or} \quad \frac{\Delta_1 Z}{\Delta t} = \mp \sin L$$

and

$$\Delta_2 Z = -\tan h' \cot Z' \, \Delta h \quad \text{or} \quad \frac{\Delta_2 Z}{\Delta h} = -\tan h' \cot Z'$$

Our tables on pages 170 and 172 give the absolute values of each one of these co-efficients $\frac{\Delta h}{\Delta t}$, $\frac{\Delta_1 Z}{\Delta t}$ and $\frac{\Delta_2 Z}{\Delta h}$ and at the top of page 170 the signs of the first two for each one of the four cases. $\frac{\Delta_2 Z}{\Delta h}$ is *always negative* provided Z' is smaller than 90° in absolute value, as our tables give it.

The correction ΔZ is generally negligible or unimportant unless Δt is large, but even in this case ΔZ can be small, depending as it does upon $\Delta_1 Z$ and $\Delta_2 Z$ with their signs + and −.

---

[1] Combinations of lines of position with terrestial bearings, with lines of soundings or with one or more lines of position are not discussed here, and will be found in any up-to-date text-book on Navigation or Nautical Astronomy.

[2] *Vide* Dott. G. Pesci, *Rivista Marittima* for January 1909, page 62. In this article he shows how Δh can be simplified by dividing it by cos L and then $\frac{\Delta h}{\cos L} = \mp \sin Z' \Delta t$ represents Δh *expressed in minutes of longitude.* In order to find it then it is only necessary to multiply Δt by sin Z'.

Taking our typical example it would be worked out as follows:

$a = 12^\circ\ 0'$
$b = 12^\circ\ 26'.5$
$L_{D.R.} = 16\ 16\ S$

$d = 12^\circ\ 10'\ N$

$t_{D.R.} = 12^\circ\ 24'\ E$
$t_{A.} = 12\ 17'$
$\Delta t = +\ 7'$

$h_o = 59^\circ\ 0'$
Corr. $= +\ 10$
$h = 59^\circ\ 10'$

$C = 28^\circ\ 42'.5$

$h' = 59^\circ\ 5'.1$
$\Delta h = -\ 2\ .7$
$h_{D.R.} = 59^\circ\ 2'.4$
$h - h_{D.R.} = +\ 7'.6$

$Z' = 23^\circ\ 53'$
$\Delta_1 Z = +\ 2$
$\Delta_2 Z = +\ 10$
$Z_{D.R.} = 24^\circ\ 5'$ NE

$\frac{\Delta h}{\Delta t} = -0.39$
$\frac{\Delta_1 Z}{\Delta t} = +0.28$
$\frac{\Delta_2 Z}{\Delta h} = -3.8$

With 5 decimal place logarithms we would find $h_{D.R.} = 59^\circ\ 2'.4$ and $Z_{D.R.} = 24^\circ\ 5'$.

The *altitude difference* $+7'.6$ is exactly equal to the distance between A and B on the chart, and shows that "no greater accuracy is gained by determining the line of position from A than from A'."

The disposition of the arguments of the tables permits us to take, on the *assumed* meridian ($38^\circ\ 11'$ W.), *any* latitude comprised between $15^\circ\ 33'.5$ and $16^\circ\ 33'.5$ and the computed point will fall between B'' and B' on the line of position.

If we took $L_{A.} = 16^\circ\ 0'$ the *altitude difference* would be small ($= 10'$ only), and the computed point would practically coincide with B.

If we took $L_{A.} = 16^\circ\ 10'.6$ the *altitude difference* would be *nil* ($0'$) and the line of position could be *immediately* drawn. This $L_{A.}$ is found by deducing the value of C that corresponds to $h_{A.} = h$. This C combined with b by means of our fundamental precepts gives $L_{A.}$:

d and $L_{A.}$ same name $\begin{cases} t < 90^\circ \begin{cases} L_{A.} < b : L_{A.} = b - C;\ Z < 90^\circ \\ L_{A.} > b : L_{A.} = b + C;\ Z > 90^\circ \end{cases} \\ t > 90^\circ\ .\ .\ . : L_{A.} = b + C;\ Z < 90^\circ \end{cases}$

d and $L_{A.}$ contrary names . . . . : $L_{A.} = C - b$; $Z > 90^\circ$

This shows the elasticity of our method whereby a better line of position (if necessary) can be plotted from a different assumed position without much additional calculation.

Meridian Sights.[1]

When a celestial body is on the meridian, its hour angle t is either 0° or 180°, according to its position above or below the elevated pole. Its azimuth Z is then also 0° or 180°. It is 0° when the sight is taken with the observer's "*face* towards the elevated pole," and 180° when he has to turn his "*back* towards the elevated pole," to take the sight.

Introducing these values in groups of equations (3) and (1) we find that

$$a = 0^\circ\ 0',\ d = b \text{ and } h = B.$$

[1] Sights can generally be considered as *meridian* when $a < 0^\circ\ 15'$.

This means that meridian sights could be worked out in column $a=0°\ 0'$ of our tables. It is better, however, to deduce directly from our general precepts, or from those giving L on page xxviii, special precepts giving *immediately* L with h and d.

These precepts will present the advantage, over the usual way of treating meridian sights, of doing away with the necessity of finding the meridian zenith distance, and giving it a confusing name or sign, such as now is in practice (N or + when facing South, and S or − when facing North). They show that even this simple time-honoured problem is capable of further simplification.

Precepts for Meridian Sights.

$Z=0°$ { Face towards elevated pole { $t=0°$: $L=(h+d)-90°$; d and L same name. / $t=180°$: $L=(90°+h)-d$; d and L „ „

$Z=180°$ { Back towards elevated pole { $t=0°$: $L=(90°+d)-h$; d and L „ „ / $t=0°$: $L=90°-(h+d)$; d and L contr. names.

In Fig. 2 the 1st case corresponds to a body between P and Z.
„ „ 2nd „ „ „ P „ N.
„ „ 3rd „ „ „ Z „ Q.
„ „ 4th „ „ „ Q „ S.

1. *Example.* On August 27, 1908, in Lat. by D. R. 2° 40′ N., and Long. by D. R. 47° 22′ W., the observed meridian altitude of the sun's lower limb was 82° 21′. $Z=0°$ (*face* towards elevated pole and $t=0°$). Find the latitude.

Our Way.		Usual Way.	
$h\odot$ =	82° 21′	$h\odot$ =	82° 21′
Corr. =	+ 10.5	Corr. =	+ 10.5
$h\odot$ =	82° 31′.5	$h\odot$ =	82° 31′.5
$d\odot$ =	10 7.0 N	$z\odot$ =	7° 28′.5 S
$L=9)2°$	38′.5 N	$d\odot$ =	10 7.0 N
		L =	2° 38′.5 N

2. *Example.* On September 5, 1908, in Lat. by D. R. 35° N., and Long. by D. R. 70° 30′ W., the observed meridian altitude of the sun's lower limb was 61° 28′.1. $Z=180°$ (*back* towards elevated pole). Find the latitude.

Our Way.		Usual Way.	
$h\odot$ =	61° 28′.1	$h\odot$ =	61° 28′.1
Corr. =	+ 10.2	Corr. =	+ 10.2
$h\odot$ =	61° 38′.3	$h\odot$ =	61° 38′.3
$90°+d\odot=9)6$	48.3 N	$z\odot$ =	28° 21′.7 N
L =	35° 10′ N	$d\odot$ =	6 48.3 N
		L =	35° 10′ N

Sights of the Moon, Stars, and Planets.

Observations of the Moon, Stars, and Planets are worked out the same way as those of the Sun, excepting the way in which the $t_{D.R.}$ is determined. After correcting the chronometer and finding G. M. T. this interval of mean time is converted into an interval of sidereal time to which is added the Sidereal Time at Greenwich Mean Noon (or the R.A.M.S. at the same instant) in order to find G. S. T.[1] This G. S. T. combined with the observed body's R. A. will give us the body's geographical longitude ($t_{G.}$), or its hour angle from Greenwich. This $t_{G.}$ is converted *immediately* into arc and combined with the Long. by D. R., finally giving the body's $t_{D.R.}$

Example.

C. =	9^h	39^m	43^s
C. C. =	−	13	16
G. M. T. =	9^h	26^m	27^s
Accel. =	+	1	33
R. A. M. S. =	10	17	20
G. S. T. =	19^h	45^m	20^s
R. A. =	14	11	28
t_G. =	5^h	33^m	52^s

or $t_{G.}$ (in arc) = 83° 28′ W

$G_{D.R.}$ = 43 42 W

$t_{D.R.}$ = 39° 46′ W

Sights of *a* Ursæ Minoris (*Polaris*).

Sights of *Polaris* are more easily and rapidly worked out, on account of its high declination: 88° 50′ in 1910, and the consequent small value of a, always less than 1° 10′.

For this declination, the tables on pages 168 and 169 show that a and b vary very slowly for large variations of t, and it is then possible to determine immediately their exact values by inspection.

Turning to pages 54 and 55 of the tables, we notice that large variations of a do not sensibly affect the values of h for a given value of B. Whether a is 0° 0′, 0° 30′, or 1° 0′, we have practically always $B=h$ up to $B=70°$. Therefore it is not necessary to determine a exactly.

---

[1] The use of a sidereal chronometer on board ship would simplify matters and render more attractive observations of the Moon, Stars, and Planets. However, a mean time chronometer may be considered a sidereal chronometer as long as its daily rate is taken as $+3^m\ 56^s.56 \pm$ daily rate. If the *Nautical Almanac* gave the Sun's, the Moon's, and the Planets' declinations and right ascensions for 0^h G. S. T., only one process for finding $t_{G.}$ would need to be followed in all cases, and no mean time chronometers would be necessary.

As *Polaris* increases in declination (its Annual Variation is only 19″), the exact value of b can be obtained by simple interpolation between $d=88°\ 50'$ and $d=89°\ 0'$.

Example.[1] On March 6, 1910, in Longitude 37° W., at $10^h\ 11^m\ 35^s$ Greenwich Mean Time, suppose the true altitude of *Polaris* to be 46° 17′.5. Required the latitude (or the line of position).

G. M. T. =	10^h	11^m	35^s
Accel. =	+	1	41
R. A. M. S. =	22	53	21
G. S. T. =	9^h	6^m	37^s
R. A. =	1	27	0
t_G. =	7^h	39^m	37^s

or t_G. (in arc) = 114° 54′ W

$G_{D.R.}$ = 37 0 W

$t_{D.R.}$ = 77° 54′ W

Entering the tables with $d=88°\ 50'$, and $t_{D.R.}=77°\ 54'$, we find immediately $a=1°\ 9'$ and $b=89°\ 45'$. (As b corresponds to the *exact* value of d, it is not necessary to re-enter the tables with a and b as arguments, as explained on page xx). Entering the tables again with $a=1°\ 0'$, we find corresponding to $h=46°\ 17'.5$: $B=46°\ 18'.5$ and $Z=1°\ 27'$. Combining this B with b by means of the precepts[2] for finding L at the bottom of page 168 ($t<90°$), we have

$$L=46°\ 3'.5\ \text{N.}$$

With the latitude thus determined and the longitude by D. R., we find a position through which the line of position is drawn, as usual, perpendicular to the Star's true bearing.

As *Polaris*' azimuth is generally very small, the parallel of latitude will in the great majority of cases practically coincide with the line of position.

Lines of Position Determined without Azimuths.

If we assumed the latitude as 15° 33′.5, instead of 16° 33′.5, C would be 28°, $h_A=59°\ 44'$, and $Z_A=24°\ 22'$. As the assumed longitude is the same, 38° 11′ W., the assumed position would be A'' (*vide* Fig. 4), and the altitude difference $-34'$.

With the two assumed positions A' and A'' (60′ apart on the same meridian) and the two altitude differences $+21'$ and $-34'$ the line of position can be found by drawing a line tangent to the two dotted circles drawn from A' and A'' respectively with 21′ and 34′ as radii.

This process appearing now for the first time gives a line of position independent of the observed body's azimuth, and its use

[1] Taken from the *Nautical Almanac* for 1910 for the sake of comparison.

[2] In the case of *Polaris* the four precepts for finding L with b and B are reduced to two, because L, in practice, is not *greater* than b, and d and L cannot be of *contrary names.*

facilitates the plotting of the line of position. It will prove very useful for plotting with great accuracy lines of position on Mercator's chart when the latitude is higher than 45°, especially when the body is near the prime vertical and the altitude difference large.

No error is committed in the plotting of the line when the altitude difference is $\leq 60'$ up to 75° latitude. With the ordinary process of plotting lines, as described on page xxv, a *maximum* error of 1° is introduced in the direction of the line of position when the azimuth is 90° with an

altitude difference	=	60′	when the latitude	=	45°
"	"	48′	"	"	50°
"	"	42′	"	"	55°
"	"	36′	"	"	60°
"	"	28′	"	"	65°

A comparison of the two azimuths will control the coincidence of the straight line of position $B'B''$ and the curve of position (not represented on the chart), as it is evident the greater the difference between the two azimuths less will the two lines coincide.

However, this comparison need only be made when $t<45°$ and the observed body's declination is smaller than its altitude ($d<h$).[1] When $t>45°$, and $d<h$, $d>h$, or $d=h$, the curve of position and the straight line of position on Mercator's chart coincide within 1′ for a distance equal to or greater than 83′ ($83'\sqrt{\cos L}$ in miles) on each side of the ship's most probable position. (*Vide* "Table for controlling the coincidence of lines of position," on page 173).

In our typical example the line of position $B'B''$ coincides with the corresponding curve of position within 1 mile for a distance of 59.5 miles on each side of the ship's most probable position B. B_1 and B_2, 30 miles from B, are only 0.2 of a mile distant from the curve of position. B_3 and B_4 (not shown on the chart), 59.5 miles from B, are just 1 mile distant, and limit the *useful* part of the straight line of position.

Rectification of Lines of Position.

As the altitude of a celestial body increases, its zenith distance or the radius of the circle of position decreases, so it might happen that at a certain distance from the "computed point" the circle of position (or curve of position on Mercator's chart) and the straight line of position do not practically coincide.

The practical coincidence of the two lines takes place when the extreme points of the two lines are not further apart than 1 mile, as

[1] For details *vide* the author's: "Limites de coincidencia da recta Marcq Saint Hilaire com a curva de posição correspondente." (Reprinted from the *Revista Maritima Brazileira*, July 1906, page 41.)

in the case considered in Fig. 4. This limit can be increased or decreased according to the accuracy sought by the navigator, since it must not be forgotten that the circle of position is the line that contains the observer's position and that the straight line of position is only a *practical substitute.*

When only one line of position is determined it is generally not necessary to rectify it, that is to change its direction and position so that it will represent better the circle of position in the vicinity desired.

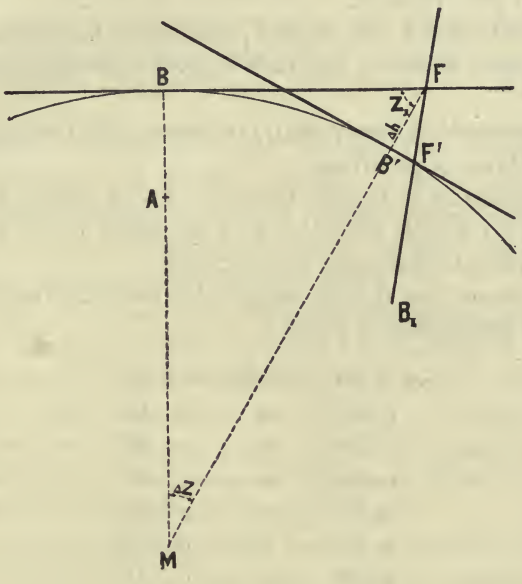

FIG. 5.

Let BF and B_1F in Fig. 5 be two lines of position, and F their intersection generally taken as the ship's position. Let us suppose that the body giving the line B_1F was low enough for us to be sure it is a practical substitute for the circle, meaning that F is less than 1′ from the circle of position. On the other hand, the body giving BF was very high (above 60°), and F is more than 1′ from the circle of position BB'. This means that F (the intersection of the two straight lines) is not a practical substitute for the intersection of the two circles of position (only one BB' being represented in the figure for demonstration).

It is then necessary to rectify BF. The tables[1] for rectifying lines

[1] Abridged, by special permission of the author, from those accompanying a very remarkable article, entitled "Sulla Teoria e la Pratica della Nuova Navigazione Astronomica," by DOTT. A. ALESSIO, Tenente di Vascello, Royal Italian Navy, published as a "supplement" to the *Rivista Marittima* for July–August 1908. *Vide* also Professor G. PES' very interesting letter in the *Rivista Marittima* for March 1909, Appendice, page 14.

of position give the values of $FB' = \Delta h$ and Z_1 with the altitude h and the distance $D = BF$, and these are sufficient for determining the new line of position $B'F'$ perpendicular to FB'. This new line intersects the line B_1F in F', which is taken as the ship's position.

Sometimes it may be necessary to rectify both lines, or to rectify one of them a second time, but this is very rare in practice.

This method recently devised by Lieut. ALESSIO saves the trouble of calculating a new *altitude difference* and *azimuth* for determining the line of position $B'F'$ from F.

We have considered the angle Z_1 instead of the *azimuth difference* ΔZ given by Lieut. ALESSIO, because it saves drawing a perpendicular to BF.

When the altitude is lower than 60° generally it will not be necessary to rectify lines of position.

When the altitude is higher than 60° use a distance D in miles corresponding to which $\Delta h = 0'.5$, $1'$, $2'$ or more miles for the given altitude, according to the scale of the chart.

The tables show that the departure (Δh) between the circle and the straight line of position is $\leq 1'$ for

$h \leq 60°$	when	$D \leq 60'$
„ $65°$	„	„ $54'$
„ $70°$	„	„ $48'$
„ $75°$	„	„ $42'$
„ $82°$	„	„ $30'$
„ $86°$	„	„ $22'$
„ $89°$	„	„ $11'$

ALTITUDE AND AZIMUTH FOR SIGHTING

By determining the approximate altitudes and azimuths of several planets and bright stars, such as VENUS and JUPITER, *Sirius*, *Canopus*, *Vega*, *Capella*, *Rigel*, *Arcturus*, *Procyon*, *Achernar*, &c., it is possible to take sights of them in broad daylight, provided their positions are far enough away from the Sun to be visible with the high power inverting telescope.

The previous knowledge of the approximate altitudes and azimuths of these and of many other celestial bodies will also enable the navigator during the twilight to take good sights of them in rapid succession with a daylight[1] horizon, long before it would be possible to locate them with the naked eye alone.

Naturally the problem is the same as explained before on page xv,

[1] A brief account of the possibilities of daytime observations of stars and planets is given by Mr. C. E. MUMFORD (Union Castle Line), in his very interesting little pamphlet, "How to Identify Unknown Stars, &c." London, 1909, 6d.

but as not so great accuracy is necessary the required altitudes and azimuths are found by inspection without interpolating.

The following precepts will show when the body is below the horizon, and therefore it cannot be seen at the time:

d and L same name . . . . . $t > 90°$ . . . . $L + b < 90°$

d and L contrary names . . . $\begin{cases} t < 90° \ldots L + b > 90° \\ t > 90° \end{cases}$

If, for some reason, the bodies were not observed at the time for which the altitudes were calculated, the table giving the rate of "change of altitude per minute of time" on page 174 will enable the observer to find the altitude before or after a certain interval of time.

IDENTIFICATION OF CELESTIAL BODIES

The identification of celestial bodies, or star identification, is of prime importance nowadays, and is strictly indispensable when only one or a few stars are showing at a time. In this case it is impossible to identify the observed stars by alignments.

By rendering "*the star observer independent of any previous knowledge of the name of the star he observes*," and "*by enabling him to identify it from the data used in his observation together with its approximate true bearing*,"[1] our tables will permit, on account of the great number of arguments, the identification of any one of the 316 stars above magnitude 4.1 catalogued in the *Nautical Almanac*, without doubt or confusion, and practically without interpolation.[2]

Therefore, the greatest difficulty in the use of stars—the uncertainty or ignorance of the names of the stars observed—will be overcome.

A star is identified in the *Nautical Almanac* by means of its Right Ascension and Declination. The Right Ascension is found by combining the Greenwich Sidereal Time with the star's geographical longitude. This t_G is found by combining the star's hour angle with the longitude by D. R.

We have then to find the star's hour angle t and its declination d. They can be easily and readily obtained from our tables, if we know the star's true altitude and azimuth, or true bearing,[3] the

[1] H. W. HARVEY, "What Star is it?" Tables for identifying unknown stars. London, 1909, page 3.

[2] α Ursæ Minoris (*Polaris*) is not included in this number, but is easily identified without computation. Below 70° latitude its greatest azimuth is 3°.4, and its altitude is always within 1° 10′ of the exact latitude of the observer.

[3] When this azimuth or true bearing cannot be obtained by compass observation, determine by means of 3 or more altitudes taken in 3 or more minutes the rate of "change of altitude per minute of time," and our "change of altitude table" on page 174 will give approximately the azimuth with the rate of change, and the observer's latitude. Ex. Lat. 32° and rate of change 9′.0 : Azimuth, 45°.

This method of finding the azimuth does not give good results when the body is near the prime vertical, as the table shows.

observer's latitude and longitude by D. R., and the Greenwich time of the observation.

Thus, the problem of identifying celestial bodies is the reverse of the problem of determining altitude and azimuth.

Given h, Z and L, find d and t.

Determination of d and t.

The lower equations of groups of equations (3) and (4) on page xiii are perfectly similar to the upper ones, and show, if we enter the tables with h and Z as arguments in place of d and t respectively, we will find in column a an approximate value of a, and in column b an approximate value of B.

Entering the tables again with a and B as arguments, we will find approximately the values of h and Z given. When greater accuracy is required a more exact value of B can be determined for the *exact* value of h.

The values of d and t will then be found in the same column a corresponding to b or its complement c.

Determination of $90°-b$ or c.

The following precepts deduced from those for determining C facilitate the determination of c given L and B, and present the same advantages as the others. The name of the declination is readily shown.

$$Z<90° \begin{cases} L<B \ldots c=B-L \ldots ; d \text{ and } L \text{ same name} & t<90° \\ L>B \ldots c=L-B \ldots ; d \text{ " } L \text{ " " } \ldots & t>90° \end{cases}$$

$$Z>90° \begin{cases} L+B>90° : c=180°-(L+B) ; d \text{ " } L \text{ " " } \ldots & t<90° \\ L+B<90° : c=L+B \ldots ; d \text{ " } L \text{ contrary names} & t<90° \end{cases}$$

When $Z<90°$, the *smaller* of the two quantities L and B is always subtracted from the *larger* of the two.

When $Z>90°$, L and B are always added together. If their sum is greater than 90°, it is subtracted from 180°.

The following example is one of many presenting themselves daily to navigators.

Example. On August 26, 1908, about $6^h\ 30^m$ P.M., in Lat. by D. R.

0° 20′ N., and Long. by D. R. 44° 23′ W., the weather being cloudy, a bright star appeared and was observed through a break in the clouds in a S.W. direction, bearing true 17°.5 at $9^h\ 41^m\ 14^s$ of the Chronometer, $13^m\ 16^s$ fast of G. M. T. The true altitude at the same instant was 23° 48′. The Sidereal Time at Greenwich Mean Noon (R. A. M. S.), was $10^h\ 17^m\ 20^s$. It was doubtful whether the star was α^2 or β Centauri, both being close to one another, and approximately of the same magnitude. What star was it?

$a = 16°\ 0'$

$B = 24°\ 50'$ $\quad h = 23°\ 48'$ $\quad Z = 17°.5$ SW ($Z > 90°$)

$L = 0\ 20$

$c = 25°\ 10'$ $\quad d = 60°\ 28'$ S $\quad t = 33°\ 59'$ W

$G_{D.R.} = 44\ 23$ W

$t_G = 78°\ 22'$ W

C. $= 9^h\ 41^m\ 14^s$

C.C. $= -\ 13\ 16$

G. M. T. $= 9^h\ 27^m\ 58^s$

Accel. $= +\ 1\ 33$

R. A. M. S. $= 10\ 17\ 20$

G. S. T. $= 19^h\ 46^m\ 51^s$

$t_G = 5\ 13\ 28$ W

R. A. $= 14^h\ 33^m\ 23^s$[1]

Running through the *Nautical Almanac*, where stars are catalogued, we find

R. A. $= 14^h\ 33^m\ 21^s$, $d = 60°\ 27'\ 30''$ } α^2 Centauri.

Once known that the observed star was α^2 Centauri, we would work out the sight for position, and would find

$L_A = 0°\ 10'$ N. and $G_A = 44°\ 23'$ W.

$h_A = 23°\ 58'$ „ $Z_A = 17°\ 34'$ S.W.

with very little extra calculation.

TIME-AZIMUTHS FOR DEVIATION

These tables constitute *ideal time-azimuth tables*, as a little examination and comparison with other tables will show.

For the Sun and other celestial bodies with declinations less than 24°, time-azimuths can be easily and rapidly found without interpolation for every 30′ (2 minutes of time) hour angles and every 1° of latitude. The hour angle interval increases slowly with the increasing declinations and decreases slowly for increasing values of a, while the latitude interval remains constant throughout.

[1] The determination of the R. A. by means of the G. S. T. and the t_G, instead of determining it (as usually is done) by means of the R. A. M. (A. T. S. + ⊙'s R. A.) and the t, might seem longer, but it must be remembered that stars are identified for position (not for pleasure), and G. S. T. and the t_G enter in this calculation, whereas the R. A. M. and the ⊙'s R. A. are of no use at all afterwards, and give less accurate results.

Time-azimuths are found by the same method used for determining h and Z for lines of position, and as h is not necessary it is not taken into consideration. Unless great accuracy is required (which is not the case in practice) b can be immediately found by inspection without interpolating.

Example. August 26, 1908, A.M. Lat. by D. R. 0° 30′ S., and Long. by D. R. 41° 40′ W. The Sun's compass bearing was taken at $23^h\ 3^m\ 0^s$ Greenwich mean time. What was the Sun's true bearing or azimuth at the same instant?

G. M. T. = $23^h\ 3^m\ 0^s$
Eq. of T. = − 1 56
G. A. T. = $23^h\ 1^m\ 4^s$
⊙'s t_G = 0 58 56 E
⊙'s t_G = 14° 44′ E
$G_{D.R.}$ = 41 40 W
⊙'s $t_{D.R.}$ = 56° 24′ E

a = 55° 0′
b = 18° 30′
L = 0 30 S
C = 19° 0′

⊙'s d = 10° 29′ N

⊙'s Z = 77° 9′ NE

TIME-ALTITUDE-AZIMUTHS

When d, t and h are given to find Z the tables give immediately its value.

Example. Same as above for time-azimuth. Given d = 10° 29′, t = 56° 24′, and h = 32° 51′, find Z.

Entering the tables with d and t as arguments, we will find in column a: 55° 0′, which is an approximate value of a, and in column b: 18°, an approximate value of b. Entering the tables again with a = 55° 0′ and b = 18° as arguments, we will find approximately the values of d and t. In the same column a = 55° 0′ corresponding to h = 32° 51′ we will find Z = 77° 9′.

DISTANCE AND COURSE IN GREAT CIRCLE SAILING

The problem of finding distance and course in Great Circle Sailing may also be easily solved by our tables, because it is the same as determining altitude and azimuth. The distance corresponds to the zenith distance or complement of the altitude and the course to the azimuth. The only difference is that the distance between the two given points can be greater than 90°, whereas the zenith distance cannot be greater than 90°.

In Fig. 1 let A be the port of departure, M be the port of arrival and P the pole nearest to A. $PQP'Q'$ the meridian of Greenwich and $QA'M'Q'$ the Equator.

If L is the latitude of the port of departure A, L' the latitude of

the port of arrival M and MPA or t the difference in longitude between the two ports, the following precepts enable us to determine the value of C given L and b and indicate also in the last two columns if the distance D and the course C_1 are smaller or greater than 90°. When $<90°$ the values of D and C_1 given by the tables are the right ones. When $>90°$ subtract the values found from 180°.

L' and L same name

$t<90°$ { $L<b$ . . : $C=b-L$; $D<90°$ and $C_1<90°$* ; $L>b$ . . . : $C=L-b$; $D<90°$ „ $C_1>90°$* }

$t>90°$ { $L+b>90°$: $C=L+b$; $D<90°$ „ $C_1<90°$* ; $L+b<90°$: $C=L+b$; $D>90°$ „ $C_1<90°$ }

L' and L contrary names

$t<90°$ { $L+b<90°$: $C=L+b$; $D<90°$ „ $C_1>90°$* ; $L+b>90°$: $C=L+b$; $D>90°$ „ $C_1>90°$ }

$t>90°$ { $L>b$ . . : $C=L-b$; $D>90°$ „ $C_1<90°$; $L<b$ . . : $C=b-L$; $D>90°$ „ $C_1>90°$ }

* These are the four cases corresponding to those for finding h and Z ($D<90°$). When $L+b$ is greater than 90° it is subtracted from 180°.

In our tables L' takes the place of d, $90°-D$ the place of h, and C_1 the place of Z.

We are of the opinion, however, that the Great Circle charts[1] offer a more simple and practical solution of the problem, and the tables only ought to be used when they are not at hand.

LUNAR DISTANCES

We have already stated in the INTRODUCTION that the problem of calculating Lunar Distances is similar to the problem of determining Distance in Great Circle Sailing.

In Fig. 1 on page ix, let M be the Moon, A the other body observed, and P the pole nearest to A. MA will be the Lunar Distance. If $QA'M'Q'$ is the celestial Equator and Q the first point of Aries or the true vernal equinox, QPA' or QA' will be the Right Ascension of A, QPM' or QM' the Right Ascension of the Moon and $A'PM'=t$ equal to the difference between the two Right Ascensions. If we represent MM', the declination of the Moon by d_M and AA' the declination of the other body observed by d_A, the following formulæ and precepts will enable us to calculate the Lunar Distance $MA=D$ without dealing with algebraic signs or arcs greater than 90°.

$$\tan b = \tan d_M \sec t$$
$$\cos D = \sin d_M \cos C \operatorname{cosec} b$$

[1] *Vide* "The Development of Great Circle Sailing," by G. W. Littlehales, U.S. Hydrographic Office, Second Edition, Washington, 1899.

d_M and d_A same name . . .

$t<90^\circ$ { $d_A<b$ . . : $C=b-d_A$; $D<90^\circ$; $d_A>b$ . . : $C=d_A-b$; $D<90^\circ$

$t>90^\circ$ { $d_A+b>90^\circ$: $C=d_A+b$; $D<90^\circ$; $d_A+b<90^\circ$: $C=d_A+b$; $D>90^\circ$

d_M and d_A contrary names

$t<90^\circ$ { $d_A+b<90^\circ$: $C=d_A+b$; $D<90^\circ$; $d_A+b>90^\circ$: $C=d_A+b$; $D>90^\circ$

$t>90^\circ$ { $d_A>b$ . . : $C=d_A-b$; $D>90^\circ$; $d_A<b$ . . : $C=b-d_A$; $D>90^\circ$

For the sake of comparison we will work out the example explained on page 232 of the *Nautical Almanac* for 1910, Part I.

EXAMPLE I.—MOON AND SUN.

To find the *true distance* between the Moon and the Sun at noon, Greenwich Mean Time, on March 8, 1910.

From the *Nautical Almanac*, Part I.

	RIGHT ASCENSION.		DECLINATION.	
Sun	$23^h\ 12^m\ 20^s.0$		$5^\circ\ 7'\ 9''$ S (d_A)	
Moon	$20\ 41\ 3.4$		$23\ 2\ 50$ S (d_M)	
diff.	$2^h\ 31^m\ 16^s.6$	or	$37^\circ\ 49'\ 9''=t$	

log tan d_M = 9.628846
log sec t = 0.102400
log tan b = 9.731246
$b=28^\circ\ 18'\ 21''$
$d_A=\ 5\ \ 7\ \ 9$
$C=23^\circ\ 11'\ 12''$

log sin d_M = 9.592720
log cos C = 9.963423
log cosec b = 0.324059
log cos D = 9.880202
$D=40^\circ\ 37'\ 48''$

Therefore, 40° 37′ 48″ is the *true distance* between the Moon and the Sun at noon on March 8, 1910.

ALL OTHER PROBLEMS SOLVED

All the other problems in Nautical Astronomy depending upon the solution of right-angled spherical triangles can be easily solved by these tables.

Some of these problems are: Amplitudes and horizon-azimuths, hour angle of a celestial body in the horizon (approximate time of sunset and sunrise, &c.), altitude and hour angle of a celestial body on the prime vertical, altitude and hour angle of a celestial body when position angle is 90°, &c.

Problem	Formula	Formula
Fundamental Formulæ	**sin a = cos d sin t**	**cot b = cot d cos t**
Amplitudes...given d and L	sin d = cos L sin $(90° - Z)$	cot $(90° - d) = -$ cot L cos t
Horizon azimuths ... „ d „ t	sin Z = cos d sin t	When d and L are of the same name, take $180° - b$ for value of t.
When variation in altitude is the greatest and variation in azimuth the least (d and L same name). Body on prime vertical: $d < L$	sin d = cos $(90° - L)$ sin h	cot L = cot d cos t
When variation in altitude is the greatest and variation in azimuth the least (d and L same name). Body's position angle is 90°: $d > L$	sin L = cos $(90° - d)$ sin h	cot d = cot L cos t

A comparison of the formulæ for solving these problems with the fundamental formulæ will immediately show the navigator how to proceed. It is well to notice that, except the case in which horizon-azimuths are found by the formulæ

$$\sin Z = \cos d \sin t,$$

the required quantity is always found in the tables *from underneath* in column t.

Amplitudes.

To find the amplitude of a celestial body in the true horizon enter the tables with L in the place of d. Run up column a with d opposite which will be found $90° - Z$ in column t.

Amplitudes of the Sun for compass correction are generally the only ones observed and for a height of the eye = 10^m (33 ft.) the Sun's centre is on the true horizon when its lower limb is about 24′ ($\frac{3}{4}$ of its diameter) above the horizon.

Example. $L = 37°$ N., and $d = 22°$ N. (rising), we will find $90° - Z = 28°$ E.: N.

The amplitude always takes the name of the declination.

Sometimes it may be more convenient to observe the Sun just when its lower limb touches the horizon. A small correction given in the table below will then have to be applied to the amplitude found by the formula

$$\sin d = \cos L \sin (90° - Z).$$

Dec.	Latitude.							
	0°	10°	20°	30°	40°	50°	60°	65°
0°	0°.0	0°.1	0°.2	0°.2	0°.4	0°.5	0°.8	0°.9
10	.0	.1	.2	.3	.4	.6	.8	1.0
20	.0	.1	.2	.3	.4	.6	1.0	1.6
24	.0	.1	.2	.3	.4	.7	1.3	3.4

d and *L* same name . . . . . *add* correction *to* $90°-Z$
d and *L* contrary names . . *subtract* „ *from* „

This table will be practically good for heights of the eye varying from 6^m to 15^m (20 ft. to 49 ft.).

To find the hour angle of a body in the true horizon enter the tables with *L* in the place of *d*. Run up column *b* with $90°-d$ opposite which will be found *t* in column *t*.

Example. $L=37°$ N., and $d=22°$ N. (rising), we will find $t=108°$ E.

Horizon-Azimuths.

To find horizon-azimuths enter the tables with *d* and *t* (or $180°-t$) as arguments. In column *a* we will find *Z*.

Example. $d=22°$ N., and $t=108°$ E. We will have $Z=62°$ N.E. They always take the name of the declination.

Body on Prime Vertical.

To find the altitude of a celestial body on the prime vertical enter tables with $90°-L$ in the place of *d*, and run up column *a* with *d*. In column *t* will be found *h*.

To find the hour angle of a celestial body on the prime vertical enter tables with *d* as argument, and run up column *b* with *L*. In column *t* will be found *t*. In column *a* will be found $90°-h$.

Example. $d=8°$ N., and $L=39°$ N. We will find $h=12°\ 47'$, and $t=80°$.

Body's Position Angle: 90°.

To find the altitude of a celestial body when its position angle is 90° enter tables with $90°-d$ in the place of *d*, and run up column *a* with *L*. In column *t* will be found *h*.

To find the hour angle of a celestial body when its position angle is 90° enter tables with *L* in the place of *d*, and run up column *b* with *d*. In column *t* will be found *t*. In column *a* will be found $90°-h$.

Example. $d=23°$ S., and $L=12°$ S. We will find $h=32°\ 9'$, and $t=60°$.

CONCLUSION

The author since 1908, during a trip from Rio de Janeiro to New York on the s.s. *Voltaire*—Lamport and Holt—has worked out many sights for lines of position taken under various circumstances by his modified tables and the improved methods as explained here, with the most satisfactory results.

Only two openings of the tables are necessary. The first is immediately indicated by the value of *d*, and the second by the value of *a*. No time is lost in turning pages. If indexed the desired pages will be found quicker.

The fact that the perpendicular *a* is common to the two right-angled triangles reduces the bulk of the tables to a *minimum*.

The use of an *assumed* position instead of the position by D. R. greatly simplifies the calculations involved in the determination of *h* and *Z*, as we have seen.

In the typical example presented no actual figures used have been suppressed. The tables give *h* with an approximation of *one minute*, and in the majority of cases with greater approximation. *Z* is always found with sufficient approximation for practical use.

The simplicity and readiness with which all the other problems are also solved show that: They are "*the simplest and readiest in solution.*"

APPENDIX I

> Navigators "ought to be spared the waste of time in making calculations, which can be 'better done once for all by a single computer on dry land.'"
>
> LORD KELVIN. Letter to Lord Ellenborough, R.N., December 4, 1902. ["Stars and Sextants," Published by J. D. Potter, London, 1903.]
>
> It is easier to turn pages than to interpolate.

In order to spare navigators "the waste of time in making calculations," and especially to reduce the chances of error to a *minimum*, the author proposes, as a simple and easy solution of the problem, an extension of his tables where *d* and *t* would be tabulated for every *minute of arc* (1′) of *a* and every *thirty minutes of arc* (30′) of *b*.

With such tables, occupying a little over 1000 pages in large 8vo, no interpolation would be necessary, and the only calculation

involved would be the determination of C with L and b by means of our simple precepts.

Thus the problem of determining lines of position at sea would be *nearly* as simple as the problem of determining latitude by a meridian sight.

Our typical example on page xxiii would be solved by such tables as follows:

$a = 12^\circ\ 13'$	G. A. T. $= 1^h\ 43^m\ 36^s$	or $t_G = 25^\circ\ 54'$ W
$b = 12^\circ\ 27'$	$d = 12^\circ\ 10'$ N	$t_A = 12\ \ 30$ E
$L_A = 16\ \ 3$ S		$G_A = 38^\circ\ 24'$ W

	$h_o = 59^\circ\ 0'$	
	Corr. $= +\ 10$	
	$h = 59^\circ\ 10'$	
$C = 28^\circ\ 30'$	$h_A = 59\ 12$	$Z_A = 24^\circ\ 24'$ NE
	$h - h_A = -\ 2'$	

Explanation.

Entering the tables with $d = 12^\circ\ 10'$, and $t_A = 12^\circ\ 30'$, as arguments, we would find *immediately* $a = 12^\circ\ 13'$, and $b = 12^\circ\ 27'$.

(As b corresponds to the *exact* value of d, it is not necessary to re-enter the tables with a and b as arguments, as explained on page xx.)

Entering the tables again with $a = 12^\circ\ 13'$ and $C = 28^\circ\ 30'$, as arguments, we would find *immediately* $h_A = 59^\circ\ 12'$, and $Z_A = 24^\circ\ 24'$.[1]

Although it is well known that "it is easier to turn pages than to interpolate," the question appears whether it would be worth while to extend the tables as mentioned above in order to do away with the two simple interpolations occurring in our method.

However, it would be convenient to extend the tabulation for every $10'$ of a, and for every 1° of b. The tables would then have 360 pages similar to those published now.

If these tables meet with success, the author will publish the above 360 page tables, which he is already preparing for his own use.[2]

---

[1] This method may be advantageously used with the present tables when the hour angle t is near 90°, especially when the declination is large. Hardly any calculation is then necessary to find h and Z.

Example. $d = 30^\circ\ 15'$ S., $t = 89^\circ\ 0'$, and $L = 10^\circ\ 17'$ S. We would find $a = 59^\circ\ 44'$, $b = 88^\circ\ 17'$, $C = 78^\circ\ 0'$, $h = 6^\circ\ 1'$, and $Z = 60^\circ\ 17'$.

[2] The author has decided to reduce these 360 pages to 166 in view of the fact that the factors $\frac{60'}{\Delta}$ and $\frac{\Delta}{60'}$ are not necessary for every $10'$ of a. (January, 1912.)

APPENDIX II

The true spirit of the "Newest Navigation" requires the plotting of each line of position upon Mercator's chart or upon squared paper representing a Plane chart, and for this reason we have given Figs. 3 and 4 showing how these lines are plotted.[1]

However, the classical NOON position deduced by combining the morning (or afternoon) sight with the meridian sight of the Sun continues and will continue to render good services to many navigators, and at the request of several friends, we have decided to add this Appendix showing how the NOON position can be easily and rapidly determined with our Tables by *calculation alone.*

This case also applies itself to the combination of a time sight with the meridian sight of any celestial body.

Example.—The same as on page xix. The distance run from 8 A.M. to Noon is represented by GT (Fig. 3): 5′.5 N. in latitude and 40′.1 W. in longitude.

The observed meridian altitude of the Sun was 42° 35′.6. BACK towards the elevated pole.

What was the ship's position at NOON?

G. M. T. = $21^h\ 13^m\ 10^s$
Eq. of T. = − 13 46
G. A. T. = $20^h\ 59^m\ 24^s$

$a = 52°\ 0'$ $\quad t_G. = 3^h\ 00^m\ 36^s$ E or $t_G. = 45°\ 9'.0$ E

$b = 17°\ 8'.4$ $\quad d = 10°\ 27'$ S $\quad t_A. = 53\ 15'.3$ E

$L_A. = 36\ 51.6$ N $\quad G_A. = 8°\ 6'.3$ W

Corr. = 8′.9 W

$h_o = 20°\ 59'.2$ $\quad G_A.\ C. = 8°\ 15'.2$ W

Corr. = + 7 .8 $\quad$ Pagel = 4 .7 W

$h = 21°\ 7'.0$ $\quad G$ at 8^h A.M. = 8° 19′.9 W

$C = 54°\ 0'$ $\quad h_A. = 21\ 13.0$ $\quad g =$ 40 .1 W

$h - h_A. = -\ 6'.0$ $\quad G$ at NOON = 9° 0′.0 W

$Z_A. =$ S 58° E

$\frac{\Delta t}{\Delta h} = 1.48$ and $p = 0.79$

$L_A. = 36°\ 51'.6$ N $\quad h_m \odot = 42°\ 35'.6$

$l =$ 5 .5 N $\quad$ Corr. = + 9 .2

$L_A.$ at NOON = 36° 57′.1 N $\quad h \odot = 42°\ 44'.8$

L at NOON = 36 51 .1 N $\quad d \odot = 10\ 24.1$ S

True latitude 6′.0 to the South $\quad h + d = 53°\ 8'.9$

L at NOON = 36° 51′.1 N

[1] See also "The New Navigation: Presented in a Familiar Way for Captains and Officers of the Merchant Service." By F. C. Cross, Lieut. R.N.R. Glasgow: James Brown & Son. Price 2s. net.

Explanation.

The first part of the calculation is developed as explained on page xx.

The application of the first correction (Corr.$=8'.9$ W) to G_A. gives us the longitude of the point G where the line of position GBL intersects the assumed parallel of latitude 36° 51′.6 N. This correction is found by multiplying the coefficient $\frac{\Delta t}{\Delta h}=1.48$ by $h-h_A.=6'$. This coefficient $\frac{\Delta t}{\Delta h}$ is taken from the Table[1] on page 171 giving the "Change of Hour Angle per Minute of Arc of Altitude" by extrapolation.

When $h-h_A.$ is *plus* (+) the name of the correction is East or West according to the name of the azimuth.

When $h-h_A.$ is *minus* (−) the name is contrary to the name of the azimuth, as in our case.

The longitude factor or Pagel's coefficient is obtained from the Tables, as explained on page xvii.

Thus, entering the Tables on page 122 with $L=37°$ in column b/B and with $Z=58°$ in column Z we would find 0.79, which is the "change of hour angle or of longitude per minute of arc of latitude." The name of the longitude correction or Pagel's correction, or simply the Pagel, 4′.7 (the result of the multiplication of 0.79 by the difference 6′.0 between the two latitudes: the assumed brought up to Noon and the meridian latitude), is easily given by Johnson's well-known rule: "Under the sun's bearing at the time of the observation write the opposite bearing, and suppose the letters to be connected diagonally, then that connected with the name of the correction for latitude will be the name of the correction for the longitude."[2]

Thus

S E
↘
N W

and as the meridian latitude was 6′.0 to the South of the assumed latitude, the Pagel 4′.7 is to W.

The third and last correction is $g=40'.1$ W for the run in longitude from the time of observation to Noon.[3]

---

[1] This Table is limited to azimuths comprised between 60° and 90°. For observations where the azimuth is smaller than 60° a simplification results, and it is better to follow the other method, slightly different, explained further on.

[2] "On Finding the Latitude and Longitude in Cloudy Weather, &c.," page 7; 32nd edition, London, 1909. Published by Mr. J. D. Potter. Price 5s.

[3] In practice it is not necessary to apply *separately* each one of the three corrections to the assumed longitude G_A. They can be combined and the result then applied to G_A.. The total correction to be applied to $G_A.=8°\ 6'.3$ W. would be 53′.7 W. (8′.9 W.+4′.7 W.+40′.1 W) giving us immediately G at Noon$=9°\ 0'.0$ W.

Therefore N, in Fig. 3, represents the ship's position at NOON.

ANOTHER SIMPLIFIED METHOD.

When the azimuth of the observed body is smaller than 60° we can use with more advantage the process explained on page xxviii, it not being necessary to apply to G_A. the correction due to $h-h_A$., reduced to 0 in this case.

Our example would be developed as follows:—

$a=52°\ 0'$	$t_G.=3^h\ 00^m\ 36^s$ E	or	$t_G.=45°\ 9'.0$ E
$b=17°\ 8'.4$	$d=10°\ 27'$ S		$t_A.=53\ 15.3$ E
	$h_o=20°\ 59'.2$		$G_A.=8°\ 6'.3$ W
	Corr. $=+\ 7.8$		Pagel $=\ 13'.7$ W
$C=54°\ 11'.3$	$h=21°\ 7'.0$	G at 8^h A.M. $=8°\ 20'.0$ W	
	$Z_A.=$ S 58° E		$g=\ 40'.1$ W
$L_A.=37°\ 2'.9$ N	$p=0.79$	G at NOON $=9°\ 0'.1$ W	
$l=\ 5.5$ N			
$L_A.$ at NOON $=37°\ 8.4$ N			
L at NOON $=36°\ 51.1$ N			
True latitude $17'.3$ to the South			

After finding the values of a, b and $t_A.$ as explained before, the assumed longitude $G_A.=8°\ 6'.3$ W. is determined. In order to determine the assumed latitude $L_A.=37°\ 2'.9$, the latitude of L in Fig. 3, where $h=h_A.$ and therefore $h-h_A.=0$, we deduce the value of C corresponding to the true altitude $h=21°\ 7'.0$ and we find $C=54°\ 11'.3$. This value of C combined with $b=17°\ 8'.4$ gives us $L_A.=37°\ 2'.9$.

The corrections for finding the true longitude at NOON are then found, as explained before on page xlvi. This process, evidently very simple, will always render good services when the azimuth is *smaller* than 60°, especially to those navigating the North Atlantic Ocean from Europe to the United States of America and *vice versâ* in winter time.

When the azimuth is *larger* than 60° it is better to use the first process explained in this Appendix, because then to small changes of h correspond large changes of C, and the assumed latitude would sometimes differ *very much* from the true latitude, therefore making the longitude correction or the PAGEL too large and not very exact.

Although the author obtained in 1910 very good results going from England to the United States on board the Brazilian battleship *Minas Geraes* with azimuths as large as 77° and 78°.5, he would advise the method to be used with care beyond 60°.

For exercise, work out the same examples by both methods with $a=51°\ 30'$ instead of $a=52°\ 0'$.

APPENDIX III

An interesting article recently published by Mr. H. B. GOODWIN in the *Nautical Magazine* for February 1912, page 176, describing "A New Form of Table for Calculating Altitude" from an *assumed position*, interpolation being reduced to the odd minutes of declination, has suggested to us this Appendix, where we will show how easily and rapidly the altitude *alone* from an *assumed position* can be found by inspection in our Tables, by simply "interchanging the latitude L and the declination d."

Only one simple interpolation is required for the odd minutes of declination, as in Mr. GOODWIN'S method.

This interchanging of L and d in our Tables geometrically corresponds to dropping the perpendicular a from Z upon the circle of declination MP (Fig. 2), instead of dropping it from the body M upon the meridian PZQ.

This perpendicular has the disadvantage of dividing the azimuth Z into two parts.

Special Tables for solving the triangle thus divided were published in Paris, in 1893, by Lieut. R. DELAFON, French Navy, and are entitled "Méthode rapide pour déterminer les Droites et Courbes de Hauteur et faire le Point." [1]

For the sake of comparison we will take and work out Mr. GOODWIN'S example on page 186 by means of our Tables.

April 22, 1911, at $4^h\ 12^m$ Greenwich Apparent Time, in latitude by account, 36° 41′ N., longitude 32° 47′ W., the Sun's altitude was observed, the declination being 11° 58′.2 N.

Find the position to be assumed, and calculate the zenith distance at that point for the time of observation.

$a = 23°\ 30'$	G. A. T. $= 4^h\ 12^m\ 00^s$	or	$t_G = 63°\ 0'$
$b = 41°\ 0'.0$	$L_A = 36°\ 59'$ N		$t_A = 29\ 57$
$d = 11\ 58.2$			$G_A = 33°\ 3'$
$C = 29°\ 1'.8$	$h_A = 53°\ 18'.7$		

If h_A is reduced to $L = 37°$ N. and $t = 30°$ (Mr. GOODWIN'S assumed position) we would find

$$h = 53°\ 16'.1 \text{ or } z = 36°\ 43'.9.$$

He found

$$h = 53°\ 15'.6 \text{ or } z = 36°\ 44'.4.$$

[1] Berger Levrault et C^ie., Editeurs.

Explanation.

Entering the Tables with $L=37°$ in the place of $d=37°$ and $t=30°$ on page 102, we find in column a approximately $a=23°\ 30'$. Entering on page 84 in column $a=23°\ 30'$, we find in column d/h, $L_{A.}=36°\ 59'$, and in column t/Z, $t_{A.}=29°\ 57'$.

They correspond to $b=41°$. Combining this b with the declination $d=11°\ 58'.2$ we find $C=29°\ 1'.8$.

Therefore entering the Tables on the next page 85 in column $a=23°\ 30'$ we find corresponding to $C=29°\ 1'.8$: $h_{A.}=53°\ 18'.7$. If necessary, the position angle would be found alongside this $h_{A.}$ in column t/Z, approximately equal to 41° 53′.

This is the "simplest and readiest" way of finding altitude *alone* from an *assumed* position.

However, as the *azimuth* is *always* necessary (except when the method explained on page xxxi is used) to show the direction of the line of position or to facilitate the calculation of the corrections it is *always* preferable to use our method for determining *simultaneously* the altitude and the azimuth, as explained on pages xix *et seq.*

It is the "*simplest and readiest in solution.*"

THE "NEWEST" NAVIGATION
ALTITUDE AND AZIMUTH TABLES

PLANE TRAVERSE TABLES

Plane Traverse Table

Course.	D=1′		D=2′		D=3′		D=4′		D=5′		D=6′		D=7′		D=8′		D=9′		D=10′		D=11′		Course.
	Lat	Dep	Lat	Dep	Lat	Dep	Lat	Dep	Lat	Dep	Lat	Dep	Lat	Dep	Lat	Dep	Lat	Dep	Lat	Dep	Lat	Dep	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	1.0	0.0	2.0	0.0	3.0	0.0	4.0	0.0	5.0	0.0	6.0	0.0	7.0	0.0	8.0	0.0	9.0	0.0	10.0	0.0	11.0	0.0	90
1	1.0	0.0	2.0	0.0	3.0	0.1	4.0	0.1	5.0	0.1	6.0	0.1	7.0	0.1	8.0	0.1	9.0	0.2	10.0	0.2	11.0	0.2	89
2	1.0	0.0	2.0	0.1	3.0	0.1	4.0	0.1	5.0	0.2	6.0	0.2	7.0	0.2	8.0	0.3	9.0	0.3	10.0	0.3	11.0	0.4	88
3	1.0	0.1	2.0	0.1	3.0	0.2	4.0	0.2	5.0	0.3	6.0	0.3	7.0	0.4	8.0	0.4	9.0	0.5	10.0	0.5	11.0	0.6	87
4	1.0	0.1	2.0	0.1	3.0	0.2	4.0	0.3	5.0	0.3	6.0	0.4	7.0	0.5	8.0	0.6	9.0	0.6	10.0	0.7	11.0	0.8	86
5	1.0	0.1	2.0	0.2	3.0	0.3	4.0	0.3	5.0	0.4	6.0	0.5	7.0	0.6	8.0	0.7	9.0	0.8	10.0	0.9	11.0	1.0	85
6	1.0	0.1	2.0	0.2	3.0	0.3	4.0	0.4	5.0	0.5	6.0	0.6	7.0	0.7	8.0	0.8	9.0	0.9	9.9	1.0	10.9	1.1	84
7	1.0	0.1	2.0	0.2	3.0	0.4	4.0	0.5	5.0	0.6	6.0	0.7	6.9	0.9	7.9	1.0	8.9	1.1	9.9	1.2	10.9	1.3	83
8	1.0	0.1	2.0	0.3	3.0	0.4	4.0	0.6	5.0	0.7	5.9	0.8	6.9	1.0	7.9	1.1	8.9	1.3	9.9	1.4	10.9	1.5	82
9	1.0	0.2	2.0	0.3	3.0	0.5	4.0	0.6	4.9	0.8	5.9	0.9	6.9	1.1	7.9	1.3	8.9	1.4	9.9	1.6	10.9	1.7	81
10	1.0	0.2	2.0	0.3	3.0	0.5	3.9	0.7	4.9	0.9	5.9	1.0	6.9	1.2	7.9	1.4	8.9	1.6	9.8	1.7	10.8	1.9	80
11	1.0	0.2	2.0	0.4	2.9	0.6	3.9	0.8	4.9	1.0	5.9	1.1	6.9	1.3	7.9	1.5	8.8	1.7	9.8	1.9	10.8	2.1	79
12	1.0	0.2	2.0	0.4	2.9	0.6	3.9	0.8	4.9	1.0	5.9	1.2	6.8	1.5	7.8	1.7	8.8	1.9	9.8	2.1	10.8	2.3	78
13	1.0	0.2	1.9	0.4	2.9	0.7	3.9	0.9	4.9	1.1	5.8	1.3	6.8	1.6	7.8	1.8	8.8	2.0	9.7	2.2	10.7	2.5	77
14	1.0	0.2	1.9	0.5	2.9	0.7	3.9	1.0	4.9	1.2	5.8	1.5	6.8	1.7	7.8	1.9	8.7	2.2	9.7	2.4	10.7	2.7	76
15	1.0	0.3	1.9	0.5	2.9	0.8	3.9	1.0	4.8	1.3	5.8	1.6	6.8	1.8	7.7	2.1	8.7	2.3	9.7	2.6	10.6	2.8	75
16	1.0	0.3	1.9	0.6	2.9	0.8	3.8	1.1	4.8	1.4	5.8	1.7	6.7	1.9	7.7	2.2	8.7	2.5	9.6	2.8	10.6	3.0	74
17	1.0	0.3	1.9	0.6	2.9	0.9	3.8	1.2	4.8	1.5	5.7	1.8	6.7	2.0	7.7	2.3	8.6	2.6	9.6	2.9	10.5	3.2	73
18	1.0	0.3	1.9	0.6	2.9	0.9	3.8	1.2	4.8	1.5	5.7	1.9	6.7	2.2	7.6	2.5	8.6	2.8	9.5	3.1	10.5	3.4	72
19	0.9	0.3	1.9	0.7	2.8	1.0	3.8	1.3	4.7	1.6	5.7	2.0	6.6	2.3	7.6	2.6	8.5	2.9	9.5	3.3	10.4	3.6	71
20	0.9	0.3	1.9	0.7	2.8	1.0	3.8	1.4	4.7	1.7	5.6	2.1	6.6	2.4	7.5	2.7	8.5	3.1	9.4	3.4	10.3	3.8	70
21	0.9	0.4	1.9	0.7	2.8	1.1	3.7	1.4	4.7	1.8	5.6	2.2	6.5	2.5	7.5	2.9	8.4	3.2	9.3	3.6	10.3	3.9	69
22	0.9	0.4	1.9	0.7	2.8	1.1	3.7	1.5	4.6	1.9	5.6	2.2	6.5	2.6	7.4	3.0	8.3	3.4	9.3	3.7	10.2	4.1	68
23	0.9	0.4	1.8	0.8	2.8	1.2	3.7	1.6	4.6	2.0	5.5	2.3	6.4	2.7	7.4	3.1	8.3	3.5	9.2	3.9	10.1	4.3	67
24	0.9	0.4	1.8	0.8	2.7	1.2	3.7	1.6	4.6	2.0	5.5	2.4	6.4	2.8	7.3	3.3	8.2	3.7	9.1	4.1	10.0	4.5	66
25	0.9	0.4	1.8	0.8	2.7	1.3	3.6	1.7	4.5	2.1	5.4	2.5	6.3	3.0	7.3	3.4	8.2	3.8	9.1	4.2	10.0	4.6	65
26	0.9	0.4	1.8	0.9	2.7	1.3	3.6	1.8	4.5	2.2	5.4	2.6	6.3	3.1	7.2	3.5	8.1	3.9	9.0	4.4	9.9	4.8	64
27	0.9	0.5	1.8	0.9	2.7	1.4	3.6	1.8	4.5	2.3	5.3	2.7	6.2	3.2	7.1	3.6	8.0	4.1	8.9	4.5	9.8	5.0	63
28	0.9	0.5	1.8	0.9	2.6	1.4	3.5	1.9	4.4	2.3	5.3	2.8	6.2	3.3	7.1	3.8	7.9	4.2	8.8	4.7	9.7	5.2	62
29	0.9	0.5	1.7	1.0	2.6	1.5	3.5	1.9	4.4	2.4	5.2	2.9	6.1	3.4	7.0	3.9	7.9	4.4	8.7	4.8	9.6	5.3	61
30	0.9	0.5	1.7	1.0	2.6	1.5	3.5	2.0	4.3	2.5	5.2	3.0	6.1	3.5	6.9	4.0	7.8	4.5	8.7	5.0	9.5	5.5	60
31	0.9	0.5	1.7	1.0	2.6	1.5	3.4	2.1	4.3	2.6	5.1	3.1	6.0	3.6	6.9	4.1	7.7	4.6	8.6	5.2	9.4	5.7	59
32	0.8	0.5	1.7	1.1	2.5	1.6	3.4	2.1	4.2	2.6	5.1	3.2	5.9	3.7	6.8	4.2	7.6	4.8	8.5	5.3	9.3	5.8	58
33	0.8	0.5	1.7	1.1	2.5	1.6	3.4	2.2	4.2	2.7	5.0	3.3	5.9	3.8	6.7	4.4	7.5	4.9	8.4	5.4	9.2	6.0	57
34	0.8	0.6	1.7	1.1	2.5	1.7	3.3	2.2	4.1	2.8	5.0	3.4	5.8	3.9	6.6	4.5	7.5	5.0	8.3	5.6	9.1	6.2	56
35	0.8	0.6	1.6	1.1	2.5	1.7	3.3	2.3	4.1	2.9	4.9	3.4	5.7	4.0	6.6	4.6	7.4	5.2	8.2	5.7	9.0	6.3	55
36	0.8	0.6	1.6	1.2	2.4	1.8	3.2	2.4	4.0	2.9	4.9	3.5	5.7	4.1	6.5	4.7	7.3	5.3	8.1	5.9	8.9	6.5	54
37	0.8	0.6	1.6	1.2	2.4	1.8	3.2	2.4	4.0	3.0	4.8	3.6	5.6	4.2	6.4	4.8	7.2	5.4	8.0	6.0	8.8	6.6	53
38	0.8	0.6	1.6	1.2	2.4	1.8	3.2	2.5	3.9	3.1	4.7	3.7	5.5	4.3	6.3	4.9	7.1	5.5	7.9	6.2	8.7	6.8	52
39	0.8	0.6	1.6	1.3	2.3	1.9	3.1	2.5	3.9	3.1	4.7	3.8	5.4	4.4	6.2	5.0	7.0	5.7	7.8	6.3	8.5	6.9	51
40	0.8	0.6	1.5	1.3	2.3	1.9	3.1	2.6	3.8	3.2	4.6	3.9	5.4	4.5	6.1	5.1	6.9	5.8	7.7	6.4	8.4	7.1	50
41	0.8	0.7	1.5	1.3	2.3	2.0	3.0	2.6	3.8	3.3	4.5	3.9	5.3	4.6	6.0	5.2	6.8	5.9	7.5	6.6	8.3	7.2	49
42	0.7	0.7	1.5	1.3	2.2	2.0	3.0	2.7	3.7	3.3	4.5	4.0	5.2	4.7	5.9	5.4	6.7	6.0	7.4	6.7	8.2	7.4	48
43	0.7	0.7	1.5	1.4	2.2	2.0	2.9	2.7	3.7	3.4	4.4	4.1	5.1	4.8	5.9	5.5	6.6	6.1	7.3	6.8	8.0	7.5	47
44	0.7	0.7	1.4	1.4	2.2	2.1	2.9	2.8	3.6	3.5	4.3	4.2	5.0	4.9	5.8	5.6	6.5	6.3	7.2	6.9	7.9	7.6	46
45	0.7	0.7	1.4	1.4	2.1	2.1	2.8	2.8	3.5	3.5	4.2	4.2	4.9	4.9	5.7	5.7	6.4	6.4	7.1	7.1	7.8	7.8	45
Course.	Dep	Lat	Dep	Lat	Dep	Lat	Dep	Lat	Dep	Lat	Dep	Lat	Dep	Lat	Dep	Lat	Dep	Lat	Dep	Lat	Dep	Lat	Course.
	D=1′		D=2′		D=3′		D=4′		D=5′		D=6′		D=7′		D=8′		D=9′		D=10′		D=11′		

Plane Traverse Table

Course.	D=12′		D=13′		D=14′		D=15′		D=16′		D=17′		D=18′		D=19′		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	12.0	0.0	13.0	0.0	14.0	0.0	15.0	0.0	16.0	0.0	17.0	0.0	18.0	0.0	19.0	0.0	90
1	12.0	0.2	13.0	0.2	14.0	0.2	15.0	0.3	16.0	0.3	17.0	0.3	18.0	0.3	19.0	0.3	89
2	12.0	0.4	13.0	0.5	14.0	0.5	15.0	0.5	16.0	0.6	17.0	0.6	18.0	0.6	19.0	0.7	88
3	12.0	0.6	13.0	0.7	14.0	0.7	15.0	0.8	16.0	0.8	17.0	0.9	18.0	0.9	19.0	1.0	87
4	12.0	0.8	13.0	0.9	14.0	1.0	15.0	1.0	16.0	1.1	17.0	1.2	18.0	1.3	19.0	1.3	86
5	12.0	1.0	13.0	1.1	13.9	1.2	14.9	1.3	15.9	1.4	16.9	1.5	17.9	1.6	18.9	1.7	85
6	11.9	1.3	12.9	1.4	13.9	1.5	14.9	1.6	15.9	1.7	16.9	1.8	17.9	1.9	18.9	2.0	84
7	11.9	1.5	12.9	1.6	13.9	1.7	14.9	1.8	15.9	1.9	16.9	2.1	17.9	2.2	18.9	2.3	83
8	11.9	1.7	12.9	1.8	13.9	1.9	14.9	2.1	15.8	2.2	16.8	2.4	17.8	2.5	18.8	2.6	82
9	11.9	1.9	12.8	2.0	13.8	2.2	14.8	2.3	15.8	2.5	16.8	2.7	17.8	2.8	18.8	3.0	81
10	11.8	2.1	12.8	2.3	13.8	2.4	14.8	2.6	15.8	2.8	16.7	3.0	17.7	3.1	18.7	3.3	80
11	11.8	2.3	12.8	2.5	13.7	2.7	14.7	2.9	15.7	3.1	16.7	3.2	17.7	3.4	18.7	3.6	79
12	11.7	2.5	12.7	2.7	13.7	2.9	14.7	3.1	15.7	3.3	16.6	3.5	17.6	3.7	18.6	4.0	78
13	11.7	2.7	12.7	2.9	13.6	3.1	14.6	3.4	15.6	3.6	16.6	3.8	17.5	4.0	18.5	4.3	77
14	11.6	2.9	12.6	3.1	13.6	3.4	14.6	3.6	15.5	3.9	16.5	4.1	17.5	4.4	18.4	4.6	76
15	11.6	3.1	12.6	3.4	13.5	3.6	14.5	3.9	15.5	4.1	16.4	4.4	17.4	4.7	18.4	4.9	75
16	11.5	3.3	12.5	3.6	13.5	3.9	14.4	4.1	15.4	4.4	16.3	4.7	17.3	5.0	18.3	5.2	74
17	11.5	3.5	12.4	3.8	13.4	4.1	14.3	4.4	15.3	4.7	16.3	5.0	17.2	5.3	18.2	5.6	73
18	11.4	3.7	12.4	4.0	13.3	4.3	14.3	4.6	15.2	4.9	16.2	5.3	17.1	5.6	18.1	5.9	72
19	11.3	3.9	12.3	4.2	13.2	4.6	14.2	4.9	15.1	5.2	16.1	5.5	17.0	5.9	18.0	6.2	71
20	11.3	4.1	12.2	4.4	13.2	4.8	14.1	5.1	15.0	5.5	16.0	5.8	16.9	6.2	17.9	6.5	70
21	11.2	4.3	12.1	4.7	13.1	5.0	14.0	5.4	14.9	5.7	15.9	6.1	16.8	6.5	17.7	6.8	69
22	11.1	4.5	12.1	4.9	13.0	5.2	13.9	5.6	14.8	6.0	15.8	6.4	16.7	6.7	17.6	7.1	68
23	11.0	4.7	12.0	5.1	12.9	5.5	13.8	5.9	14.7	6.3	15.6	6.6	16.6	7.0	17.5	7.4	67
24	11.0	4.9	11.9	5.3	12.8	5.7	13.7	6.1	14.6	6.5	15.5	6.9	16.4	7.3	17.4	7.7	66
25	10.9	5.1	11.8	5.5	12.7	5.9	13.6	6.3	14.5	6.8	15.4	7.2	16.3	7.6	17.2	8.0	65
26	10.8	5.3	11.7	5.7	12.6	6.1	13.5	6.6	14.4	7.0	15.3	7.5	16.2	7.9	17.1	8.3	64
27	10.7	5.4	11.6	5.9	12.5	6.4	13.4	6.8	14.3	7.3	15.1	7.7	16.0	8.2	16.9	8.6	63
28	10.6	5.6	11.5	6.1	12.4	6.6	13.2	7.0	14.1	7.5	15.0	8.0	15.9	8.5	16.8	8.9	62
29	10.5	5.8	11.4	6.3	12.2	6.8	13.1	7.3	14.0	7.8	14.9	8.2	15.7	8.7	16.6	9.2	61
30	10.4	6.0	11.3	6.5	12.1	7.0	13.0	7.5	13.9	8.0	14.7	8.5	15.6	9.0	16.5	9.5	60
31	10.3	6.2	11.1	6.7	12.0	7.2	12.9	7.7	13.7	8.2	14.6	8.8	15.4	9.3	16.3	9.8	59
32	10.2	6.4	11.0	6.9	11.9	7.4	12.7	7.9	13.6	8.5	14.4	9.0	15.3	9.5	16.1	10.1	58
33	10.1	6.5	10.9	7.1	11.7	7.6	12.6	8.2	13.4	8.7	14.3	9.3	15.1	9.8	15.9	10.3	57
34	9.9	6.7	10.8	7.3	11.6	7.8	12.4	8.4	13.3	8.9	14.1	9.5	14.9	10.1	15.8	10.6	56
35	9.8	6.9	10.6	7.5	11.5	8.0	12.3	8.6	13.1	9.2	13.9	9.8	14.7	10.3	15.6	10.9	55
36	9.7	7.1	10.5	7.6	11.3	8.2	12.1	8.8	12.9	9.4	13.8	10.0	14.6	10.6	15.4	11.2	54
37	9.6	7.2	10.4	7.8	11.2	8.4	12.0	9.0	12.8	9.6	13.6	10.2	14.4	10.8	15.2	11.4	53
38	9.5	7.4	10.2	8.0	11.0	8.6	11.8	9.2	12.6	9.9	13.4	10.5	14.2	11.1	15.0	11.7	52
39	9.3	7.6	10.1	8.2	10.9	8.8	11.7	9.4	12.4	10.1	13.2	10.7	14.0	11.3	14.8	12.0	51
40	9.2	7.7	10.0	8.4	10.7	9.0	11.5	9.6	12.3	10.3	13.0	10.9	13.8	11.6	14.6	12.2	50
41	9.1	7.9	9.8	8.5	10.6	9.2	11.3	9.8	12.1	10.5	12.8	11.2	13.6	11.8	14.3	12.5	49
42	8.9	8.0	9.7	8.7	10.4	9.4	11.1	10.0	11.9	10.7	12.6	11.4	13.4	12.0	14.1	12.7	48
43	8.8	8.2	9.5	8.9	10.2	9.5	11.0	10.2	11.7	10.9	12.4	11.6	13.2	12.3	13.9	13.0	47
44	8.6	8.3	9.4	9.0	10.1	9.7	10.8	10.4	11.5	11.1	12.2	11.8	12.9	12.5	13.7	13.2	46
45	8.5	8.5	9.2	9.2	9.9	9.9	10.6	10.6	11.3	11.3	12.0	12.0	12.7	12.7	13.4	13.4	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	D=12′		D=13′		D=14′		D=15′		D=16′		D=17′		D=18′		D=19′		

Plane Traverse Table

Course.	$D=20'$		$D=21'$		$D=22'$		$D=23'$		$D=24'$		$D=25'$		$D=26'$		$D=27'$		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	20.0	0.0	21.0	0.0	22.0	0.0	23.0	0.0	24.0	0.0	25.0	0.0	26.0	0.0	27.0	0.0	90
1	20.0	0.3	21.0	0.4	22.0	0.4	23.0	0.4	24.0	0.4	25.0	0.4	26.0	0.5	27.0	0.5	89
2	20.0	0.7	21.0	0.7	22.0	0.8	23.0	0.8	24.0	0.8	25.0	0.9	26.0	0.9	27.0	0.9	88
3	20.0	1.0	21.0	1.1	22.0	1.2	23.0	1.2	24.0	1.3	25.0	1.3	26.0	1.4	27.0	1.4	87
4	20.0	1.4	20.9	1.5	21.9	1.5	22.9	1.6	23.9	1.7	24.9	1.7	25.9	1.8	26.9	1.9	86
5	19.9	1.7	20.9	1.8	21.9	1.9	22.9	2.0	23.9	2.1	24.9	2.2	25.9	2.3	26.9	2.4	85
6	19.9	2.1	20.9	2.2	21.9	2.3	22.9	2.4	23.9	2.5	24.9	2.6	25.9	2.7	26.9	2.8	84
7	19.9	2.4	20.8	2.6	21.8	2.7	22.8	2.8	23.8	2.9	24.8	3.0	25.8	3.2	26.8	3.3	83
8	19.8	2.8	20.8	2.9	21.8	3.1	22.8	3.2	23.8	3.3	24.8	3.5	25.7	3.6	26.7	3.8	82
9	19.8	3.1	20.7	3.3	21.7	3.4	22.7	3.6	23.7	3.8	24.7	3.9	25.7	4.1	26.7	4.2	81
10	19.7	3.5	20.7	3.6	21.7	3.8	22.7	4.0	23.6	4.2	24.6	4.3	25.6	4.5	26.6	4.7	80
11	19.6	3.8	20.6	4.0	21.6	4.2	22.6	4.4	23.6	4.6	24.5	4.8	25.5	5.0	26.5	5.2	79
12	19.6	4.2	20.5	4.4	21.5	4.6	22.5	4.8	23.5	5.0	24.5	5.2	25.4	5.4	26.4	5.6	78
13	19.5	4.5	20.5	4.7	21.4	4.9	22.4	5.2	23.4	5.4	24.4	5.6	25.3	5.8	26.3	6.1	77
14	19.4	4.8	20.4	5.1	21.3	5.3	22.3	5.6	23.3	5.8	24.3	6.0	25.2	6.3	26.2	6.5	76
15	19.3	5.2	20.3	5.4	21.3	5.7	22.2	6.0	23.2	6.2	24.1	6.5	25.1	6.7	26.1	7.0	75
16	19.2	5.5	20.2	5.8	21.1	6.1	22.1	6.3	23.1	6.6	24.0	6.9	25.0	7.2	26.0	7.4	74
17	19.1	5.8	20.1	6.1	21.0	6.4	22.0	6.7	23.0	7.0	23.9	7.3	24.9	7.6	25.8	7.9	73
18	19.0	6.2	20.0	6.5	20.9	6.8	21.9	7.1	22.8	7.4	23.8	7.7	24.7	8.0	25.7	8.3	72
19	18.9	6.5	19.9	6.8	20.8	7.2	21.7	7.5	22.7	7.8	23.6	8.1	24.6	8.5	25.5	8.8	71
20	18.8	6.8	19.7	7.2	20.7	7.5	21.6	7.9	22.6	8.2	23.5	8.6	24.4	8.9	25.4	9.2	70
21	18.7	7.2	19.6	7.5	20.5	7.9	21.5	8.2	22.4	8.6	23.3	9.0	24.3	9.3	25.2	9.7	69
22	18.5	7.5	19.5	7.9	20.4	8.2	21.3	8.6	22.3	9.0	23.2	9.4	24.1	9.7	25.0	10.1	68
23	18.4	7.8	19.3	8.2	20.3	8.6	21.2	9.0	22.1	9.4	23.0	9.8	23.9	10.2	24.9	10.5	67
24	18.3	8.1	19.2	8.5	20.1	8.9	21.0	9.4	21.9	9.8	22.8	10.2	23.8	10.6	24.7	11.0	66
25	18.1	8.5	19.0	8.9	19.9	9.3	20.8	9.7	21.8	10.1	22.7	10.6	23.6	11.0	24.5	11.4	65
26	18.0	8.8	18.9	9.2	19.8	9.6	20.7	10.1	21.6	10.5	22.5	11.0	23.4	11.4	24.3	11.8	64
27	17.8	9.1	18.7	9.5	19.6	10.0	20.5	10.4	21.4	10.9	22.3	11.3	23.2	11.8	24.1	12.3	63
28	17.7	9.4	18.5	9.9	19.4	10.3	20.3	10.8	21.2	11.3	22.1	11.7	23.0	12.2	23.8	12.7	62
29	17.5	9.7	18.4	10.2	19.2	10.7	20.1	11.2	21.0	11.6	21.9	12.1	22.7	12.6	23.6	13.1	61
30	17.3	10.0	18.2	10.5	19.1	11.0	19.9	11.5	20.8	12.0	21.7	12.5	22.5	13.0	23.4	13.5	60
31	17.1	10.3	18.0	10.8	18.9	11.3	19.7	11.8	20.6	12.4	21.4	12.9	22.3	13.4	23.1	13.9	59
32	17.0	10.6	17.8	11.1	18.7	11.7	19.5	12.2	20.4	12.7	21.2	13.2	22.0	13.8	22.9	14.3	58
33	16.8	10.9	17.6	11.4	18.5	12.0	19.3	12.5	20.1	13.1	21.0	13.6	21.8	14.2	22.6	14.7	57
34	16.6	11.2	17.4	11.7	18.2	12.3	19.1	12.9	19.9	13.4	20.7	14.0	21.6	14.5	22.4	15.1	56
35	16.4	11.5	17.2	12.0	18.0	12.6	18.8	13.2	19.7	13.8	20.5	14.3	21.3	14.9	22.1	15.5	55
36	16.2	11.8	17.0	12.3	17.8	12.9	18.6	13.5	19.4	14.1	20.2	14.7	21.0	15.3	21.8	15.9	54
37	16.0	12.0	16.8	12.6	17.6	13.2	18.4	13.8	19.2	14.4	20.0	15.0	20.8	15.6	21.6	16.2	53
38	15.8	12.3	16.5	12.9	17.3	13.5	18.1	14.2	18.9	14.8	19.7	15.4	20.5	16.0	21.3	16.6	52
39	15.5	12.6	16.3	13.2	17.1	13.8	17.9	14.5	18.7	15.1	19.4	15.7	20.2	16.4	21.0	17.0	51
40	15.3	12.9	16.1	13.5	16.9	14.1	17.6	14.8	18.4	15.4	19.2	16.1	19.9	16.7	20.7	17.4	50
41	15.1	13.1	15.8	13.8	16.6	14.4	17.4	15.1	18.1	15.7	18.9	16.4	19.6	17.1	20.4	17.7	49
42	14.9	13.4	15.6	14.1	16.3	14.7	17.1	15.4	17.8	16.1	18.6	16.7	19.3	17.4	20.1	18.1	48
43	14.6	13.6	15.4	14.3	16.1	15.0	16.8	15.7	17.6	16.4	18.3	17.0	19.0	17.7	19.7	18.4	47
44	14.4	13.9	15.1	14.6	15.8	15.3	16.5	16.0	17.3	16.7	18.0	17.4	18.7	18.1	19.4	18.8	46
45	14.1	14.1	14.8	14.8	15.6	15.6	16.3	16.3	17.0	17.0	17.7	17.7	18.4	18.4	19.1	19.1	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	$D=20'$		$D=21'$		$D=22'$		$D=23'$		$D=24'$		$D=25'$		$D=26'$		$D=27'$		

Plane Traverse Table

Course.	$D=28'$		$D=29'$		$D=30'$		$D=31'$		$D=32'$		$D=33'$		$D=34'$		$D=35'$		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	28.0	0.0	29.0	0.0	30.0	0.0	31.0	0.0	32.0	0.0	33.0	0.0	34.0	0.0	35.0	0.0	90
1	28.0	0.5	29.0	0.5	30.0	0.5	31.0	0.5	32.0	0.6	33.0	0.6	34.0	0.6	35.0	0.6	89
2	28.0	1.0	29.0	1.0	30.0	1.0	31.0	1.1	32.0	1.1	33.0	1.2	34.0	1.2	35.0	1.2	88
3	28.0	1.5	29.0	1.5	30.0	1.6	31.0	1.6	32.0	1.7	33.0	1.7	34.0	1.8	35.0	1.8	87
4	27.9	2.0	28.9	2.0	29.9	2.1	30.9	2.2	31.9	2.2	32.9	2.3	33.9	2.4	34.9	2.4	86
5	27.9	2.4	28.9	2.5	29.9	2.6	30.9	2.7	31.9	2.8	32.9	2.9	33.9	3.0	34.9	3.1	85
6	27.8	2.9	28.8	3.0	29.8	3.1	30.8	3.2	31.8	3.3	32.8	3.4	33.8	3.6	34.8	3.7	84
7	27.8	3.4	28.8	3.5	29.8	3.7	30.8	3.8	31.8	3.9	32.8	4.0	33.7	4.1	34.7	4.3	83
8	27.7	3.9	28.7	4.0	29.7	4.2	30.7	4.3	31.7	4.5	32.7	4.6	33.7	4.7	34.7	4.9	82
9	27.7	4.4	28.6	4.5	29.6	4.7	30.6	4.8	31.6	5.0	32.6	5.2	33.6	5.3	34.6	5.5	81
10	27.6	4.9	28.6	5.0	29.5	5.2	30.5	5.4	31.5	5.6	32.5	5.7	33.5	5.9	34.5	6.1	80
11	27.5	5.3	28.5	5.5	29.4	5.7	30.4	5.9	31.4	6.1	32.4	6.3	33.4	6.5	34.4	6.7	79
12	27.4	5.8	28.4	6.0	29.3	6.2	30.3	6.4	31.3	6.7	32.3	6.9	33.3	7.1	34.2	7.3	78
13	27.3	6.3	28.3	6.5	29.2	6.7	30.2	7.0	31.2	7.2	32.2	7.4	33.1	7.6	34.1	7.9	77
14	27.2	6.8	28.1	7.0	29.1	7.3	30.1	7.5	31.0	7.7	32.0	8.0	33.0	8.2	34.0	8.5	76
15	27.0	7.2	28.0	7.5	29.0	7.8	29.9	8.0	30.9	8.3	31.9	8.5	32.8	8.8	33.8	9.1	75
16	26.9	7.7	27.9	8.0	28.8	8.3	29.8	8.5	30.8	8.8	31.7	9.1	32.7	9.4	33.6	9.6	74
17	26.8	8.2	27.7	8.5	28.7	8.8	29.6	9.1	30.6	9.4	31.6	9.6	32.5	9.9	33.5	10.2	73
18	26.6	8.7	27.6	9.0	28.5	9.3	29.5	9.6	30.4	9.9	31.4	10.2	32.3	10.5	33.3	10.8	72
19	26.5	9.1	27.4	9.4	28.4	9.8	29.3	10.1	30.3	10.4	31.2	10.7	32.1	11.1	33.1	11.4	71
20	26.3	9.6	27.3	9.9	28.2	10.3	29.1	10.6	30.1	10.9	31.0	11.3	31.9	11.6	32.9	12.0	70
21	26.1	10.0	27.1	10.4	28.0	10.8	28.9	11.1	29.9	11.5	30.8	11.8	31.7	12.2	32.7	12.5	69
22	26.0	10.5	26.9	10.9	27.8	11.2	28.7	11.6	29.7	12.0	30.6	12.4	31.5	12.7	32.5	13.1	68
23	25.8	10.9	26.7	11.3	27.6	11.7	28.5	12.1	29.5	12.5	30.4	12.9	31.3	13.3	32.2	13.7	67
24	25.6	11.4	26.5	11.8	27.4	12.2	28.3	12.6	29.2	13.0	30.1	13.4	31.1	13.8	32.0	14.2	66
25	25.4	11.8	26.3	12.3	27.2	12.7	28.1	13.1	29.0	13.5	29.9	13.9	30.8	14.4	31.7	14.8	65
26	25.2	12.3	26.1	12.7	27.0	13.2	27.9	13.6	28.8	14.0	29.7	14.5	30.6	14.9	31.5	15.3	64
27	24.9	12.7	25.8	13.2	26.7	13.6	27.6	14.1	28.5	14.5	29.4	15.0	30.3	15.4	31.2	15.9	63
28	24.7	13.1	25.6	13.6	26.5	14.1	27.4	14.6	28.3	15.0	29.1	15.5	30.0	16.0	30.9	16.4	62
29	24.5	13.6	25.4	14.1	26.2	14.5	27.1	15.0	28.0	15.5	28.9	16.0	29.7	16.5	30.6	17.0	61
30	24.2	14.0	25.1	14.5	26.0	15.0	26.8	15.5	27.7	16.0	28.6	16.5	29.4	17.0	30.3	17.5	60
31	24.0	14.4	24.9	14.9	25.7	15.5	26.6	16.0	27.4	16.5	28.3	17.0	29.1	17.5	30.0	18.0	59
32	23.7	14.8	24.6	15.4	25.4	15.9	26.3	16.4	27.1	17.0	28.0	17.5	28.8	18.0	29.7	18.5	58
33	23.5	15.2	24.3	15.8	25.2	16.3	26.0	16.9	26.8	17.4	27.7	18.0	28.5	18.5	29.4	19.1	57
34	23.2	15.7	24.0	16.2	24.9	16.8	25.7	17.3	26.5	17.9	27.4	18.5	28.2	19.0	29.0	19.6	56
35	22.9	16.1	23.8	16.6	24.6	17.2	25.4	17.8	26.2	18.4	27.0	18.9	27.9	19.5	28.7	20.1	55
36	22.7	16.5	23.5	17.0	24.3	17.6	25.1	18.2	25.9	18.8	26.7	19.4	27.5	20.0	28.3	20.6	54
37	22.4	16.9	23.2	17.5	24.0	18.1	24.8	18.7	25.6	19.3	26.4	19.9	27.2	20.5	28.0	21.1	53
38	22.1	17.2	22.9	17.9	23.6	18.5	24.4	19.1	25.2	19.7	26.0	20.3	26.8	20.9	27.6	21.5	52
39	21.8	17.6	22.5	18.3	23.3	18.9	24.1	19.5	24.9	20.1	25.6	20.8	26.4	21.4	27.2	22.0	51
40	21.4	18.0	22.2	18.6	23.0	19.3	23.7	19.9	24.5	20.6	25.3	21.2	26.0	21.9	26.8	22.5	50
41	21.1	18.4	21.9	19.0	22.6	19.7	23.4	20.3	24.2	21.0	24.9	21.6	25.7	22.3	26.4	23.0	49
42	20.8	18.7	21.6	19.4	22.3	20.1	23.0	20.7	23.8	21.4	24.5	22.1	25.3	22.8	26.0	23.4	48
43	20.5	19.1	21.2	19.8	21.9	20.5	22.7	21.1	23.4	21.8	24.1	22.5	24.9	23.2	25.6	23.9	47
44	20.1	19.5	20.9	20.1	21.6	20.8	22.3	21.5	23.0	22.2	23.7	22.9	24.5	23.6	25.2	24.3	46
45	19.8	19.8	20.5	20.5	21.2	21.2	21.9	21.9	22.6	22.6	23.3	23.3	24.0	24.0	24.7	24.7	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	$D=28'$		$D=29'$		$D=30'$		$D=31'$		$D=32'$		$D=33'$		$D=34'$		$D=35'$		

Plane Traverse Table

Course.	D = 36′		D = 37′		D = 38′		D = 39′		D = 40′		D = 41′		D = 42′		D = 43′		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	36.0	0.0	37.0	0.0	38.0	0.0	39.0	0.0	40.0	0.0	41.0	0.0	42.0	0.0	43.0	0.0	90
1	36.0	0.6	37.0	0.6	38.0	0.7	39.0	0.7	40.0	0.7	41.0	0.7	42.0	0.7	43.0	0.8	89
2	36.0	1.3	37.0	1.3	38.0	1.3	39.0	1.4	40.0	1.4	41.0	1.4	42.0	1.5	43.0	1.5	88
3	36.0	1.9	36.9	1.9	37.9	2.0	38.9	2.0	39.9	2.1	40.9	2.1	41.9	2.2	42.9	2.3	87
4	35.9	2.5	36.9	2.6	37.9	2.7	38.9	2.7	39.9	2.8	40.9	2.9	41.9	2.9	42.9	3.0	86
5	35.9	3.1	36.9	3.2	37.9	3.3	38.9	3.4	39.8	3.5	40.8	3.6	41.8	3.7	42.8	3.7	85
6	35.8	3.8	36.8	3.9	37.8	4.0	38.8	4.1	39.8	4.2	40.8	4.3	41.8	4.4	42.8	4.5	84
7	35.7	4.4	36.7	4.5	37.7	4.6	38.7	4.8	39.7	4.9	40.7	5.0	41.7	5.1	42.7	5.2	83
8	35.6	5.0	36.6	5.1	37.6	5.3	38.6	5.4	39.6	5.6	40.6	5.7	41.6	5.8	42.6	6.0	82
9	35.6	5.6	36.5	5.8	37.5	5.9	38.5	6.1	39.5	6.3	40.5	6.4	41.5	6.6	42.5	6.7	81
10	35.5	6.3	36.4	6.4	37.4	6.6	38.4	6.8	39.4	6.9	40.4	7.1	41.4	7.3	42.3	7.5	80
11	35.3	6.9	36.3	7.1	37.3	7.3	38.3	7.4	39.3	7.6	40.2	7.8	41.2	8.0	42.2	8.2	79
12	35.2	7.5	36.2	7.7	37.2	7.9	38.1	8.1	39.1	8.3	40.1	8.5	41.1	8.7	42.1	8.9	78
13	35.1	8.1	36.1	8.3	37.0	8.5	38.0	8.8	39.0	9.0	39.9	9.2	40.9	9.4	41.9	9.7	77
14	34.9	8.7	35.9	9.0	36.9	9.2	37.8	9.4	38.8	9.7	39.8	9.9	40.8	10.2	41.7	10.4	76
15	34.8	9.3	35.7	9.6	36.7	9.8	37.7	10.1	38.6	10.4	39.6	10.6	40.6	10.9	41.5	11.1	75
16	34.6	9.9	35.6	10.2	36.5	10.5	37.5	10.7	38.5	11.0	39.4	11.3	40.4	11.6	41.3	11.9	74
17	34.4	10.5	35.4	10.8	36.3	11.1	37.3	11.4	38.3	11.7	39.2	12.0	40.2	12.3	41.1	12.6	73
18	34.2	11.1	35.2	11.4	36.1	11.7	37.1	12.1	38.0	12.4	39.0	12.7	39.9	13.0	40.9	13.3	72
19	34.0	11.7	35.0	12.0	35.9	12.4	36.9	12.7	37.8	13.0	38.8	13.3	39.7	13.7	40.7	14.0	71
20	33.8	12.3	34.8	12.7	35.7	13.0	36.6	13.3	37.6	13.7	38.5	14.0	39.5	14.4	40.4	14.7	70
21	33.6	12.9	34.5	13.3	35.5	13.6	36.4	14.0	37.3	14.3	38.3	14.7	39.2	15.1	40.1	15.4	69
22	33.4	13.5	34.3	13.9	35.2	14.2	36.2	14.6	37.1	15.0	38.0	15.4	38.9	15.7	39.9	16.1	68
23	33.1	14.1	34.1	14.5	35.0	14.8	35.9	15.2	36.8	15.6	37.7	16.0	38.7	16.4	39.6	16.8	67
24	32.9	14.6	33.8	15.0	34.7	15.5	35.6	15.9	36.5	16.3	37.5	16.7	38.4	17.1	39.3	17.5	66
25	32.6	15.2	33.5	15.6	34.4	16.1	35.3	16.5	36.3	16.9	37.2	17.3	38.1	17.7	39.0	18.2	65
26	32.4	15.8	33.3	16.2	34.2	16.7	35.1	17.1	36.0	17.5	36.9	18.0	37.7	18.4	38.6	18.8	64
27	32.1	16.3	33.0	16.8	33.9	17.3	34.7	17.7	35.6	18.2	36.5	18.6	37.4	19.1	38.3	19.5	63
28	31.8	16.9	32.7	17.4	33.6	17.8	34.4	18.3	35.3	18.8	36.2	19.2	37.1	19.7	38.0	20.2	62
29	31.5	17.5	32.4	17.9	33.2	18.4	34.1	18.9	35.0	19.4	35.9	19.9	36.7	20.4	37.6	20.8	61
30	31.2	18.0	32.0	18.5	32.9	19.0	33.8	19.5	34.6	20.0	35.5	20.5	36.4	21.0	37.2	21.5	60
31	30.9	18.5	31.7	19.1	32.6	19.6	33.4	20.1	34.3	20.6	35.1	21.1	36.0	21.6	36.9	22.1	59
32	30.5	19.1	31.4	19.6	32.2	20.1	33.1	20.7	33.9	21.2	34.8	21.7	35.6	22.3	36.5	22.8	58
33	30.2	19.6	31.0	20.2	31.9	20.7	32.7	21.2	33.5	21.8	34.4	22.3	35.2	22.9	36.1	23.4	57
34	29.8	20.1	30.7	20.7	31.5	21.2	32.3	21.8	33.2	22.4	34.0	22.9	34.8	23.5	35.6	24.0	56
35	29.5	20.6	30.3	21.2	31.1	21.8	31.9	22.4	32.8	22.9	33.6	23.5	34.4	24.1	35.2	24.7	55
36	29.1	21.2	29.9	21.7	30.7	22.3	31.6	22.9	32.4	23.5	33.2	24.1	34.0	24.7	34.8	25.3	54
37	28.8	21.7	29.5	22.3	30.3	22.9	31.1	23.5	31.9	24.1	32.7	24.7	33.5	25.3	34.3	25.9	53
38	28.4	22.2	29.2	22.8	29.9	23.4	30.7	24.0	31.5	24.6	32.3	25.2	33.1	25.9	33.9	26.5	52
39	28.0	22.7	28.8	23.3	29.5	23.9	30.3	24.5	31.1	25.2	31.9	25.8	32.6	26.4	33.4	27.1	51
40	27.6	23.1	28.3	23.8	29.1	24.4	29.9	25.1	30.6	25.7	31.4	26.4	32.2	27.0	32.9	27.6	50
41	27.2	23.6	27.9	24.3	28.7	24.9	29.4	25.6	30.2	26.2	30.9	26.9	31.7	27.6	32.5	28.2	49
42	26.8	24.1	27.5	24.8	28.2	25.4	29.0	26.1	29.7	26.8	30.5	27.4	31.2	28.1	32.0	28.8	48
43	26.3	24.6	27.1	25.2	27.8	25.9	28.5	26.6	29.3	27.3	30.0	28.0	30.7	28.6	31.4	29.3	47
44	25.9	25.0	26.6	25.7	27.3	26.4	28.1	27.1	28.8	27.8	29.5	28.5	30.2	29.2	30.9	29.9	46
45	25.5	25.5	26.2	26.2	26.9	26.9	27.6	27.6	28.3	28.3	29.0	29.0	29.7	29.7	30.4	30.4	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	D = 36′		D = 37′		D = 38′		D = 39′		D = 40′		D = 41′		D = 42′		D = 43′		

Plane Traverse Table

Course.	D=44′		D=45′		D=46′		D=47′		D=48′		D=49′		D=50′		D=51′		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	44.0	0.0	45.0	0.0	46.0	0.0	47.0	0.0	48.0	0.0	49.0	0.0	50.0	0.0	51.0	0.0	90
1	44.0	0.8	45.0	0.8	46.0	0.8	47.0	0.8	48.0	0.8	49.0	0.9	50.0	0.9	51.0	0.9	89
2	44.0	1.5	45.0	1.6	46.0	1.6	47.0	1.6	48.0	1.7	49.0	1.7	50.0	1.7	51.0	1.8	88
3	43.9	2.3	44.9	2.4	45.9	2.4	46.9	2.5	47.9	2.5	48.9	2.6	49.9	2.6	50.9	2.7	87
4	43.9	3.1	44.9	3.1	45.9	3.2	46.9	3.3	47.9	3.3	48.9	3.4	49.9	3.5	50.9	3.6	86
5	43.8	3.8	44.8	3.9	45.8	4.0	46.8	4.1	47.8	4.2	48.8	4.3	49.8	4.4	50.8	4.4	85
6	43.8	4.6	44.8	4.7	45.7	4.8	46.7	4.9	47.7	5.0	48.7	5.1	49.7	5.2	50.7	5.3	84
7	43.7	5.4	44.7	5.5	45.7	5.6	46.6	5.7	47.6	5.8	48.6	6.0	49.6	6.1	50.6	6.2	83
8	43.6	6.1	44.6	6.3	45.6	6.4	46.5	6.5	47.5	6.7	48.5	6.8	49.5	7.0	50.5	7.1	82
9	43.5	6.9	44.4	7.0	45.4	7.2	46.4	7.4	47.4	7.5	48.4	7.7	49.4	7.8	50.4	8.0	81
10	43.3	7.6	44.3	7.8	45.3	8.0	46.3	8.2	47.3	8.3	48.3	8.5	49.2	8.7	50.2	8.9	80
11	43.2	8.4	44.2	8.6	45.2	8.8	46.1	9.0	47.1	9.2	48.1	9.3	49.1	9.5	50.1	9.7	79
12	43.0	9.1	44.0	9.4	45.0	9.6	46.0	9.8	47.0	10.0	47.9	10.2	48.9	10.4	49.9	10.6	78
13	42.9	9.9	43.8	10.1	44.8	10.3	45.8	10.6	46.8	10.8	47.7	11.0	48.7	11.2	49.7	11.5	77
14	42.7	10.6	43.7	10.9	44.6	11.1	45.6	11.4	46.6	11.6	47.5	11.9	48.5	12.1	49.5	12.3	76
15	42.5	11.4	43.5	11.6	44.4	11.9	45.4	12.2	46.4	12.4	47.3	12.7	48.3	12.9	49.3	13.2	75
16	42.3	12.1	43.3	12.4	44.2	12.7	45.2	13.0	46.1	13.2	47.1	13.5	48.1	13.8	49.0	14.1	74
17	42.1	12.9	43.0	13.2	44.0	13.4	44.9	13.7	45.9	14.0	46.9	14.3	47.8	14.6	48.8	14.9	73
18	41.8	13.6	42.8	13.9	43.7	14.2	44.7	14.5	45.7	14.8	46.6	15.1	47.6	15.5	48.5	15.8	72
19	41.6	14.3	42.5	14.7	43.5	15.0	44.4	15.3	45.4	15.6	46.3	16.0	47.3	16.3	48.2	16.6	71
20	41.3	15.0	42.3	15.4	43.2	15.7	44.2	16.1	45.1	16.4	46.0	16.8	47.0	17.1	47.9	17.4	70
21	41.1	15.8	42.0	16.1	42.9	16.5	43.9	16.8	44.8	17.2	45.7	17.6	46.7	17.9	47.6	18.3	69
22	40.8	16.5	41.7	16.9	42.7	17.2	43.6	17.6	44.5	18.0	45.4	18.4	46.4	18.7	47.3	19.1	68
23	40.5	17.2	41.4	17.6	42.3	18.0	43.3	18.4	44.2	18.8	45.1	19.1	46.0	19.5	46.9	19.9	67
24	40.2	17.9	41.1	18.3	42.0	18.7	42.9	19.1	43.9	19.5	44.8	19.9	45.7	20.3	46.6	20.7	66
25	39.9	18.6	40.8	19.0	41.7	19.4	42.6	19.9	43.5	20.3	44.4	20.7	45.3	21.1	46.2	21.6	65
26	39.5	19.3	40.4	19.7	41.3	20.2	42.2	20.6	43.1	21.0	44.0	21.5	44.9	21.9	45.8	22.4	64
27	39.2	20.0	40.1	20.4	41.0	20.9	41.9	21.3	42.8	21.8	43.7	22.2	44.6	22.7	45.4	23.2	63
28	38.8	20.7	39.7	21.1	40.6	21.6	41.5	22.1	42.4	22.5	43.3	23.0	44.1	23.5	45.0	23.9	62
29	38.5	21.3	39.4	21.8	40.2	22.3	41.1	22.8	42.0	23.3	42.9	23.8	43.7	24.2	44.6	24.7	61
30	38.1	22.0	39.0	22.5	39.8	23.0	40.7	23.5	41.6	24.0	42.4	24.5	43.3	25.0	44.2	25.5	60
31	37.7	22.7	38.6	23.2	39.4	23.7	40.3	24.2	41.1	24.7	42.0	25.2	42.9	25.8	43.7	26.3	59
32	37.3	23.3	38.2	23.8	39.0	24.4	39.9	24.9	40.7	25.4	41.6	26.0	42.4	26.5	43.3	27.0	58
33	36.9	24.0	37.7	24.5	38.6	25.1	39.4	25.6	40.3	26.1	41.1	26.7	41.9	27.2	42.8	27.8	57
34	36.5	24.6	37.3	25.2	38.1	25.7	39.0	26.3	39.8	26.8	40.6	27.4	41.5	28.0	42.3	28.5	56
35	36.0	25.2	36.9	25.8	37.7	26.4	38.5	27.0	39.3	27.5	40.1	28.1	41.0	28.7	41.8	29.3	55
36	35.6	25.9	36.4	26.5	37.2	27.0	38.0	27.6	38.8	28.2	39.6	28.8	40.5	29.4	41.3	30.0	54
37	35.1	26.5	35.9	27.1	36.7	27.7	37.5	28.3	38.3	28.9	39.1	29.5	39.9	30.1	40.7	30.7	53
38	34.7	27.1	35.5	27.7	36.2	28.3	37.0	28.9	37.8	29.6	38.6	30.2	39.4	30.8	40.2	31.4	52
39	34.2	27.7	35.0	28.3	35.7	28.9	36.5	29.6	37.3	30.2	38.1	30.8	38.9	31.5	39.6	32.1	51
40	33.7	28.3	34.5	28.9	35.2	29.6	36.0	30.2	36.8	30.9	37.5	31.5	38.3	32.1	39.1	32.8	50
41	33.2	28.9	34.0	29.5	34.7	30.2	35.5	30.8	36.2	31.5	37.0	32.1	37.7	32.8	38.5	33.5	49
42	32.7	29.4	33.4	30.1	34.2	30.8	34.9	31.4	35.7	32.1	36.4	32.8	37.2	33.5	37.9	34.1	48
43	32.2	30.0	32.9	30.7	33.6	31.4	34.4	32.1	35.1	32.7	35.8	33.4	36.6	34.1	37.3	34.8	47
44	31.7	30.6	32.4	31.3	33.1	32.0	33.8	32.6	34.5	33.3	35.2	34.0	36.0	34.7	36.7	35.4	46
45	31.1	31.1	31.8	31.8	32.5	32.5	33.2	33.2	33.9	33.9	34.6	34.6	35.4	35.4	36.1	36.1	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	D=44′		D=45′		D=46′		D=47′		D=48′		D=49′		D=50′		D=51′		

Plane Traverse Table

Course.	$D=52'$		$D=53'$		$D=54'$		$D=55'$		$D=56'$		$D=57'$		$D=58'$		$D=59'$		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	52.0	0.0	53.0	0.0	54.0	0.0	55.0	0.0	56.0	0.0	57.0	0.0	58.0	0.0	59.0	0.0	90
1	52.0	0.9	53.0	0.9	54.0	0.9	55.0	1.0	56.0	1.0	57.0	1.0	58.0	1.0	59.0	1.0	89
2	52.0	1.8	53.0	1.8	54.0	1.9	55.0	1.9	56.0	2.0	57.0	2.0	58.0	2.0	59.0	2.1	88
3	51.9	2.7	52.9	2.8	53.9	2.8	54.9	2.9	55.9	2.9	56.9	3.0	57.9	3.0	58.9	3.1	87
4	51.9	3.6	52.9	3.7	53.9	3.8	54.9	3.8	55.9	3.9	56.9	4.0	57.9	4.0	58.9	4.1	86
5	51.8	4.5	52.8	4.6	53.8	4.7	54.8	4.8	55.8	4.9	56.8	5.0	57.8	5.1	58.8	5.1	85
6	51.7	5.4	52.7	5.5	53.7	5.6	54.7	5.7	55.7	5.9	56.7	6.0	57.7	6.1	58.7	6.2	84
7	51.6	6.3	52.6	6.5	53.6	6.6	54.6	6.7	55.6	6.8	56.6	6.9	57.6	7.1	58.6	7.2	83
8	51.5	7.2	52.5	7.4	53.5	7.5	54.5	7.7	55.5	7.8	56.4	7.9	57.4	8.1	58.4	8.2	82
9	51.4	8.1	52.3	8.3	53.3	8.4	54.3	8.6	55.3	8.8	56.3	8.9	57.3	9.1	58.3	9.2	81
10	51.2	9.0	52.2	9.2	53.2	9.4	54.2	9.6	55.1	9.7	56.1	9.9	57.1	10.1	58.1	10.2	80
11	51.0	9.9	52.0	10.1	53.0	10.3	54.0	10.5	55.0	10.7	56.0	10.9	56.9	11.1	57.9	11.3	79
12	50.9	10.8	51.8	11.0	52.8	11.2	53.8	11.4	54.8	11.6	55.8	11.9	56.7	12.1	57.7	12.3	78
13	50.7	11.7	51.6	11.9	52.6	12.1	53.6	12.4	54.6	12.6	55.5	12.8	56.5	13.0	57.5	13.3	77
14	50.5	12.6	51.4	12.8	52.4	13.1	53.4	13.3	54.3	13.5	55.3	13.8	56.3	14.0	57.2	14.3	76
15	50.2	13.5	51.2	13.7	52.2	14.0	53.1	14.2	54.1	14.5	55.1	14.8	56.0	15.0	57.0	15.3	75
16	50.0	14.3	50.9	14.6	51.9	14.9	52.9	15.2	53.8	15.4	54.8	15.7	55.8	16.0	56.7	16.3	74
17	49.7	15.2	50.7	15.5	51.6	15.8	52.6	16.1	53.6	16.4	54.5	16.7	55.5	17.0	56.4	17.2	73
18	49.5	16.1	50.4	16.4	51.4	16.7	52.3	17.0	53.3	17.3	54.2	17.6	55.2	17.9	56.1	18.2	72
19	49.2	16.9	50.1	17.3	51.1	17.6	52.0	17.9	52.9	18.2	53.9	18.6	54.8	18.9	55.8	19.2	71
20	48.9	17.8	49.8	18.1	50.7	18.5	51.7	18.8	52.6	19.2	53.6	19.5	54.5	19.8	55.4	20.2	70
21	48.5	18.6	49.5	19.0	50.4	19.4	51.3	19.7	52.3	20.1	53.2	20.4	54.1	20.8	55.1	21.1	69
22	48.2	19.5	49.1	19.9	50.1	20.2	51.0	20.6	51.9	21.0	52.8	21.4	53.8	21.7	54.7	22.1	68
23	47.9	20.3	48.8	20.7	49.7	21.1	50.6	21.5	51.5	21.9	52.5	22.3	53.4	22.7	54.3	23.1	67
24	47.5	21.2	48.4	21.6	49.3	22.0	50.2	22.4	51.2	22.8	52.1	23.2	53.0	23.6	53.9	24.0	66
25	47.1	22.0	48.0	22.4	48.9	22.8	49.8	23.2	50.8	23.7	51.7	24.1	52.6	24.5	53.5	24.9	65
26	46.7	22.8	47.6	23.2	48.5	23.7	49.4	24.1	50.3	24.5	51.2	25.0	52.1	25.4	53.0	25.9	64
27	46.3	23.6	47.2	24.1	48.1	24.5	49.0	25.0	49.9	25.4	50.8	25.9	51.7	26.3	52.6	26.8	63
28	45.9	24.4	46.8	24.9	47.7	25.4	48.6	25.8	49.4	26.3	50.3	26.8	51.2	27.2	52.1	27.7	62
29	45.5	25.2	46.4	25.7	47.2	26.2	48.1	26.7	49.0	27.1	49.9	27.6	50.7	28.1	51.6	28.6	61
30	45.0	26.0	45.9	26.5	46.8	27.0	47.6	27.5	48.5	28.0	49.4	28.5	50.2	29.0	51.1	29.5	60
31	44.6	26.8	45.4	27.3	46.3	27.8	47.1	28.3	48.0	28.8	48.9	29.4	49.7	29.9	50.6	30.4	59
32	44.1	27.6	44.9	28.1	45.8	28.6	46.6	29.1	47.5	29.7	48.3	30.2	49.2	30.7	50.0	31.3	58
33	43.6	28.3	44.4	28.9	45.3	29.4	46.1	30.0	47.0	30.5	47.8	31.0	48.6	31.6	49.5	32.1	57
34	43.1	29.1	43.9	29.6	44.8	30.2	45.6	30.8	46.4	31.3	47.3	31.9	48.1	32.4	48.9	33.0	56
35	42.6	29.8	43.4	30.4	44.2	31.0	45.1	31.5	45.9	32.1	46.7	32.7	47.5	33.3	48.3	33.8	55
36	42.1	30.6	42.9	31.2	43.7	31.7	44.5	32.3	45.3	32.9	46.1	33.5	46.9	34.1	47.7	34.7	54
37	41.5	31.3	42.3	31.9	43.1	32.5	43.9	33.1	44.7	33.7	45.5	34.3	46.3	34.9	47.1	35.5	53
38	41.0	32.0	41.8	32.6	42.6	33.2	43.3	33.9	44.1	34.5	44.9	35.1	45.7	35.7	46.5	36.3	52
39	40.4	32.7	41.2	33.4	42.0	34.0	42.7	34.6	43.5	35.2	44.3	35.9	45.1	36.5	45.9	37.1	51
40	39.8	33.4	40.6	34.1	41.4	34.7	42.1	35.4	42.9	36.0	43.7	36.6	44.4	37.3	45.2	37.9	50
41	39.2	34.1	40.0	34.8	40.8	35.4	41.5	36.1	42.3	36.7	43.0	37.4	43.8	38.1	44.5	38.7	49
42	38.6	34.8	39.4	35.5	40.1	36.1	40.9	36.8	41.6	37.5	42.4	38.1	43.1	38.8	43.8	39.5	48
43	38.0	35.5	38.8	36.1	39.5	36.8	40.2	37.5	41.0	38.2	41.7	38.9	42.4	39.6	43.1	40.2	47
44	37.4	36.1	38.1	36.8	38.8	37.5	39.6	38.2	40.3	38.9	41.0	39.6	41.7	40.3	42.4	41.0	46
45	36.8	36.8	37.5	37.5	38.2	38.2	38.9	38.9	39.6	39.6	40.3	40.3	41.0	41.0	41.7	41.7	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	$D=52'$		$D=53'$		$D=54'$		$D=55'$		$D=56'$		$D=57'$		$D=58'$		$D=59'$		

Plane Traverse Table

Course.	$D=60'$		$D=61'$		$D=62'$		$D=63'$		$D=64'$		$D=65'$		$D=66'$		$D=67'$		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	60.0	0.0	61.0	0.0	62.0	0.0	63.0	0.0	64.0	0.0	65.0	0.0	66.0	0.0	67.0	0.0	90
1	60.0	1.0	61.0	1.1	62.0	1.1	63.0	1.1	64.0	1.1	65.0	1.1	66.0	1.2	67.0	1.2	89
2	60.0	2.1	61.0	2.1	62.0	2.2	63.0	2.2	64.0	2.2	65.0	2.3	66.0	2.3	67.0	2.3	88
3	59.9	3.1	60.9	3.2	61.9	3.2	62.9	3.3	63.9	3.3	64.9	3.4	65.9	3.5	66.9	3.5	87
4	59.9	4.2	60.9	4.3	61.8	4.3	62.8	4.4	63.8	4.5	64.8	4.5	65.8	4.6	66.8	4.7	86
5	59.8	5.2	60.8	5.3	61.8	5.4	62.8	5.5	63.8	5.6	64.8	5.7	65.7	5.8	66.7	5.8	85
6	59.7	6.3	60.7	6.4	61.7	6.5	62.7	6.6	63.6	6.7	64.6	6.8	65.6	6.9	66.6	7.0	84
7	59.6	7.3	60.5	7.4	61.5	7.6	62.5	7.7	63.5	7.8	64.5	7.9	65.5	8.0	66.5	8.2	83
8	59.4	8.4	60.4	8.5	61.4	8.6	62.4	8.8	63.4	8.9	64.4	9.0	65.4	9.2	66.3	9.3	82
9	59.3	9.4	60.2	9.5	61.2	9.7	62.2	9.9	63.2	10.0	64.2	10.2	65.2	10.3	66.2	10.5	81
10	59.1	10.4	60.1	10.6	61.1	10.8	62.0	10.9	63.0	11.1	64.0	11.3	65.0	11.5	66.0	11.6	80
11	58.9	11.4	59.9	11.6	60.9	11.8	61.8	12.0	62.8	12.2	63.8	12.4	64.8	12.6	65.8	12.8	79
12	58.7	12.5	59.7	12.7	60.6	12.9	61.6	13.1	62.6	13.3	63.6	13.5	64.6	13.7	65.5	13.9	78
13	58.5	13.5	59.4	13.7	60.4	13.9	61.4	14.2	62.4	14.4	63.3	14.6	64.3	14.8	65.3	15.1	77
14	58.2	14.5	59.2	14.8	60.2	15.0	61.1	15.2	62.1	15.5	63.1	15.7	64.0	16.0	65.0	16.2	76
15	58.0	15.5	58.9	15.8	59.9	16.0	60.9	16.3	61.8	16.6	62.8	16.8	63.8	17.1	64.7	17.3	75
16	57.7	16.5	58.6	16.8	59.6	17.1	60.6	17.4	61.5	17.6	62.5	17.9	63.4	18.2	64.4	18.5	74
17	57.4	17.5	58.3	17.8	59.3	18.1	60.2	18.4	61.2	18.7	62.2	19.0	63.1	19.3	64.1	19.6	73
18	57.1	18.5	58.0	18.9	59.0	19.2	59.9	19.5	60.9	19.8	61.8	20.1	62.8	20.4	63.7	20.7	72
19	56.7	19.5	57.7	19.9	58.6	20.2	59.6	20.5	60.5	20.8	61.5	21.2	62.4	21.5	63.3	21.8	71
20	56.4	20.5	57.3	20.9	58.3	21.2	59.2	21.5	60.1	21.9	61.1	22.2	62.0	22.6	63.0	22.9	70
21	56.0	21.5	56.9	21.9	57.9	22.2	58.8	22.6	59.7	22.9	60.7	23.3	61.6	23.7	62.5	24.0	69
22	55.6	22.5	56.6	22.9	57.5	23.2	58.4	23.6	59.3	24.0	60.3	24.3	61.2	24.7	62.1	25.1	68
23	55.2	23.4	56.2	23.8	57.1	24.2	58.0	24.6	58.9	25.0	59.8	25.4	60.8	25.8	61.7	26.2	67
24	54.8	24.4	55.7	24.8	56.6	25.2	57.6	25.6	58.5	26.0	59.4	26.4	60.3	26.8	61.2	27.3	66
25	54.4	25.4	55.3	25.8	56.2	26.2	57.1	26.6	58.0	27.0	58.9	27.5	59.8	27.9	60.7	28.3	65
26	53.9	26.3	54.8	26.7	55.7	27.2	56.6	27.6	57.5	28.1	58.4	28.5	59.3	28.9	60.2	29.4	64
27	53.5	27.2	54.4	27.7	55.2	28.1	56.1	28.6	57.0	29.1	57.9	29.5	58.8	30.0	59.7	30.4	63
28	53.0	28.2	53.9	28.6	54.7	29.1	55.6	29.6	56.5	30.0	57.4	30.5	58.3	31.0	59.2	31.5	62
29	52.5	29.1	53.4	29.6	54.2	30.1	55.1	30.5	56.0	31.0	56.9	31.5	57.7	32.0	58.6	32.5	61
30	52.0	30.0	52.8	30.5	53.7	31.0	54.6	31.5	55.4	32.0	56.3	32.5	57.2	33.0	58.0	33.5	60
31	51.4	30.9	52.3	31.4	53.1	31.9	54.0	32.4	54.9	33.0	55.7	33.5	56.6	34.0	57.4	34.5	59
32	50.9	31.8	51.7	32.3	52.6	32.9	53.4	33.4	54.3	33.9	55.1	34.4	56.0	35.0	56.8	35.5	58
33	50.3	32.7	51.2	33.2	52.0	33.8	52.8	34.3	53.7	34.9	54.5	35.4	55.4	35.9	56.2	36.5	57
34	49.7	33.6	50.6	34.1	51.4	34.7	52.2	35.2	53.1	35.8	53.9	36.3	54.7	36.9	55.5	37.5	56
35	49.1	34.4	50.0	35.0	50.8	35.6	51.6	36.1	52.4	36.7	53.2	37.3	54.1	37.9	54.9	38.4	55
36	48.5	35.3	49.4	35.9	50.2	36.4	51.0	37.0	51.8	37.6	52.6	38.2	53.4	38.8	54.2	39.4	54
37	47.9	36.1	48.7	36.7	49.5	37.3	50.3	37.9	51.1	38.5	51.9	39.1	52.7	39.7	53.5	40.3	53
38	47.3	36.9	48.1	37.6	48.9	38.2	49.6	38.8	50.4	39.4	51.2	40.0	52.0	40.6	52.8	41.2	52
39	46.6	37.8	47.4	38.4	48.2	39.0	49.0	39.6	49.7	40.3	50.5	40.9	51.3	41.5	52.1	42.2	51
40	46.0	38.6	46.7	39.2	47.5	39.9	48.3	40.5	49.0	41.1	49.8	41.8	50.6	42.4	51.3	43.1	50
41	45.3	39.4	46.0	40.0	46.8	40.7	47.5	41.3	48.3	42.0	49.1	42.6	49.8	43.3	50.6	44.0	49
42	44.6	40.1	45.3	40.8	46.1	41.5	46.8	42.2	47.6	42.8	48.3	43.5	49.0	44.2	49.8	44.8	48
43	43.9	40.9	44.6	41.6	45.3	42.3	46.1	43.0	46.8	43.6	47.5	44.3	48.3	45.0	49.0	45.7	47
44	43.2	41.7	43.9	42.4	44.6	43.1	45.3	43.8	46.0	44.5	46.8	45.2	47.5	45.8	48.2	46.5	46
45	42.4	42.4	43.1	43.1	43.8	43.8	44.5	44.5	45.3	45.3	46.0	46.0	46.7	46.7	47.4	47.4	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	$D=60'$		$D=61'$		$D=62'$		$D=63'$		$D=64'$		$D=65'$		$D=66'$		$D=67'$		

Plane Traverse Table

Course.	D=68′		D=69′		D=70′		D=71′		D=72′		D=73′		D=74′		D=75′		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	68.0	0.0	69.0	0.0	70.0	0.0	71.0	0.0	72.0	0.0	73.0	0.0	74.0	0.0	75.0	0.0	90
1	68.0	1.2	69.0	1.2	70.0	1.2	71.0	1.2	72.0	1.3	73.0	1.3	74.0	1.3	75.0	1.3	89
2	68.0	2.4	69.0	2.4	70.0	2.4	71.0	2.5	72.0	2.5	73.0	2.5	74.0	2.6	75.0	2.6	88
3	67.9	3.6	68.9	3.6	69.9	3.7	70.9	3.7	71.9	3.8	72.9	3.8	73.9	3.9	74.9	3.9	87
4	67.8	4.7	68.8	4.8	69.8	4.9	70.8	5.0	71.8	5.0	72.8	5.1	73.8	5.2	74.8	5.2	86
5	67.7	5.9	68.7	6.0	69.7	6.1	70.7	6.2	71.7	6.3	72.7	6.4	73.7	6.4	74.7	6.5	85
6	67.6	7.1	68.6	7.2	69.6	7.3	70.6	7.4	71.6	7.5	72.6	7.6	73.6	7.7	74.6	7.8	84
7	67.5	8.3	68.5	8.4	69.5	8.5	70.5	8.7	71.5	8.8	72.5	8.9	73.4	9.0	74.4	9.1	83
8	67.3	9.5	68.3	9.6	69.3	9.7	70.3	9.9	71.3	10.0	72.3	10.2	73.3	10.3	74.3	10.4	82
9	67.2	10.6	68.2	10.8	69.1	11.0	70.1	11.1	71.1	11.3	72.1	11.4	73.1	11.6	74.1	11.7	81
10	67.0	11.8	68.0	12.0	68.9	12.2	69.9	12.3	70.9	12.5	71.9	12.7	72.9	12.8	73.9	13.0	80
11	66.8	13.0	67.7	13.2	68.7	13.4	69.7	13.5	70.7	13.7	71.7	13.9	72.6	14.1	73.6	14.3	79
12	66.5	14.1	67.5	14.3	68.5	14.6	69.4	14.8	70.4	15.0	71.4	15.2	72.4	15.4	73.4	15.6	78
13	66.3	15.3	67.2	15.5	68.2	15.7	69.2	16.0	70.2	16.2	71.1	16.4	72.1	16.6	73.1	16.9	77
14	66.0	16.5	67.0	16.7	67.9	16.9	68.9	17.2	69.9	17.4	70.8	17.7	71.8	17.9	72.8	18.1	76
15	65.7	17.6	66.6	17.9	67.6	18.1	68.6	18.4	69.5	18.6	70.5	18.9	71.5	19.2	72.4	19.4	75
16	65.4	18.7	66.3	19.0	67.3	19.3	68.2	19.6	69.2	19.8	70.2	20.1	71.1	20.4	72.1	20.7	74
17	65.0	19.9	66.0	20.2	66.9	20.5	67.9	20.8	68.9	21.1	69.8	21.3	70.8	21.6	71.7	21.9	73
18	64.7	21.0	65.6	21.3	66.6	21.6	67.5	21.9	68.5	22.2	69.4	22.6	70.4	22.9	71.3	23.2	72
19	64.3	22.1	65.2	22.5	66.2	22.8	67.1	23.1	68.1	23.4	69.0	23.8	70.0	24.1	70.9	24.4	71
20	63.9	23.3	64.8	23.6	65.8	23.9	66.7	24.3	67.7	24.6	68.6	25.0	69.5	25.3	70.5	25.7	70
21	63.5	24.4	64.4	24.7	65.4	25.1	66.3	25.4	67.2	25.8	68.2	26.2	69.1	26.5	70.0	26.9	69
22	63.0	25.5	64.0	25.8	64.9	26.2	65.8	26.6	66.8	27.0	67.7	27.3	68.6	27.7	69.5	28.1	68
23	62.6	26.6	63.5	27.0	64.4	27.4	65.4	27.7	66.3	28.1	67.2	28.5	68.1	28.9	69.0	29.3	67
24	62.1	27.7	63.0	28.1	63.9	28.5	64.9	28.9	65.8	29.3	66.7	29.7	67.6	30.1	68.5	30.5	66
25	61.6	28.7	62.5	29.2	63.4	29.6	64.3	30.0	65.3	30.4	66.2	30.9	67.1	31.3	68.0	31.7	65
26	61.1	29.8	62.0	30.2	62.9	30.7	63.8	31.1	64.7	31.6	65.6	32.0	66.5	32.4	67.4	32.9	64
27	60.6	30.9	61.5	31.3	62.4	31.8	63.3	32.2	64.2	32.7	65.0	33.1	65.9	33.6	66.8	34.0	63
28	60.0	31.9	60.9	32.4	61.8	32.9	62.7	33.3	63.6	33.8	64.5	34.3	65.3	34.7	66.2	35.2	62
29	59.5	33.0	60.3	33.5	61.2	33.9	62.1	34.4	63.0	34.9	63.8	35.4	64.7	35.9	65.6	36.4	61
30	58.9	34.0	59.8	34.5	60.6	35.0	61.5	35.5	62.4	36.0	63.2	36.5	64.1	37.0	65.0	37.5	60
31	58.3	35.0	59.1	35.5	60.0	36.1	60.9	36.6	61.7	37.1	62.6	37.6	63.4	38.1	64.3	38.6	59
32	57.7	36.0	58.5	36.6	59.4	37.1	60.2	37.6	61.1	38.2	61.9	38.7	62.8	39.2	63.6	39.7	58
33	57.0	37.0	57.9	37.6	58.7	38.1	59.5	38.7	60.4	39.2	61.2	39.8	62.1	40.3	62.9	40.8	57
34	56.4	38.0	57.2	38.6	58.0	39.1	58.9	39.7	59.7	40.3	60.5	40.8	61.3	41.4	62.2	41.9	56
35	55.7	39.0	56.5	39.6	57.3	40.2	58.2	40.7	59.0	41.3	59.8	41.9	60.6	42.4	61.4	43.0	55
36	55.0	40.0	55.8	40.6	56.6	41.1	57.4	41.7	58.2	42.3	59.1	42.9	59.9	43.5	60.7	44.1	54
37	54.3	40.9	55.1	41.5	55.9	42.1	56.7	42.7	57.5	43.3	58.3	43.9	59.1	44.5	59.9	45.1	53
38	53.6	41.9	54.4	42.5	55.2	43.1	55.9	43.7	56.7	44.3	57.5	44.9	58.3	45.6	59.1	46.2	52
39	52.8	42.8	53.6	43.4	54.4	44.1	55.2	44.7	56.0	45.3	56.7	45.9	57.5	46.6	58.3	47.2	51
40	52.1	43.7	52.9	44.4	53.6	45.0	54.4	45.6	55.2	46.3	55.9	46.9	56.7	47.6	57.5	48.2	50
41	51.3	44.6	52.1	45.3	52.8	45.9	53.6	46.6	54.3	47.2	55.1	47.9	55.8	48.5	56.6	49.2	49
42	50.5	45.5	51.3	46.2	52.0	46.8	52.8	47.5	53.5	48.2	54.2	48.8	55.0	49.5	55.7	50.2	48
43	49.7	46.4	50.5	47.1	51.2	47.7	51.9	48.4	52.7	49.1	53.4	49.8	54.1	50.5	54.9	51.1	47
44	48.9	47.2	49.6	47.9	50.4	48.6	51.1	49.3	51.8	50.0	52.5	50.7	53.2	51.4	54.0	52.1	46
45	48.1	48.1	48.8	48.8	49.5	49.5	50.2	50.2	50.9	50.9	51.6	51.6	52.3	52.3	53.0	53.0	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	D=68′		D=69′		D=70′		D=71′		D=72′		D=73′		D=74′		D=75′		

Plane Traverse Table

Course.	D = 76′		D = 77′		D = 78′		D = 79′		D = 80′		D = 81′		D = 82′		D = 83′		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	76.0	0.0	77.0	0.0	78.0	0.0	79.0	0.0	80.0	0.0	81.0	0.0	82.0	0.0	83.0	0.0	90
1	76.0	1.3	77.0	1.3	78.0	1.4	79.0	1.4	80.0	1.4	81.0	1.4	82.0	1.4	83.0	1.4	89
2	76.0	2.7	77.0	2.7	78.0	2.7	79.0	2.8	80.0	2.8	81.0	2.8	82.0	2.9	82.9	2.9	88
3	75.9	4.0	76.9	4.0	77.9	4.1	78.9	4.1	79.9	4.2	80.9	4.2	81.9	4.3	82.9	4.3	87
4	75.8	5.3	76.8	5.4	77.8	5.4	78.8	5.5	79.8	5.6	80.8	5.7	81.8	5.7	82.8	5.8	86
5	75.7	6.6	76.7	6.7	77.7	6.8	78.7	6.9	79.7	7.0	80.7	7.1	81.7	7.1	82.7	7.2	85
6	75.6	7.9	76.6	8.0	77.6	8.2	78.6	8.3	79.6	8.4	80.6	8.5	81.6	8.6	82.5	8.7	84
7	75.4	9.3	76.4	9.4	77.4	9.5	78.4	9.6	79.4	9.7	80.4	9.9	81.4	10.0	82.4	10.1	83
8	75.3	10.6	76.3	10.7	77.2	10.9	78.2	11.0	79.2	11.1	80.2	11.3	81.2	11.4	82.2	11.6	82
9	75.1	11.9	76.1	12.0	77.0	12.2	78.0	12.4	79.0	12.5	80.0	12.7	81.0	12.8	82.0	13.0	81
10	74.8	13.2	75.8	13.4	76.8	13.5	77.8	13.7	78.8	13.9	79.8	14.1	80.8	14.2	81.7	14.4	80
11	74.6	14.5	75.6	14.7	76.6	14.9	77.5	15.1	78.5	15.3	79.5	15.5	80.5	15.6	81.5	15.8	79
12	74.3	15.8	75.3	16.0	76.3	16.2	77.3	16.4	78.3	16.6	79.2	16.8	80.2	17.0	81.2	17.3	78
13	74.1	17.1	75.0	17.3	76.0	17.5	77.0	17.8	77.9	18.0	78.9	18.2	79.9	18.4	80.9	18.7	77
14	73.7	18.4	74.7	18.6	75.7	18.9	76.7	19.1	77.6	19.4	78.6	19.6	79.6	19.8	80.5	20.1	76
15	73.4	19.7	74.4	19.9	75.3	20.2	76.3	20.4	77.3	20.7	78.2	21.0	79.2	21.2	80.2	21.5	75
16	73.1	20.9	74.0	21.2	75.0	21.5	75.9	21.8	76.9	22.1	77.9	22.3	78.8	22.6	79.8	22.9	74
17	72.7	22.2	73.6	22.5	74.6	22.8	75.5	23.1	76.5	23.4	77.5	23.7	78.4	24.0	79.4	24.3	73
18	72.3	23.5	73.2	23.8	74.2	24.1	75.1	24.4	76.1	24.7	77.0	25.0	78.0	25.3	78.9	25.6	72
19	71.9	24.7	72.8	25.1	73.8	25.4	74.7	25.7	75.6	26.0	76.6	26.4	77.5	26.7	78.5	27.0	71
20	71.4	26.0	72.4	26.3	73.3	26.7	74.2	27.0	75.2	27.4	76.1	27.7	77.1	28.0	78.0	28.4	70
21	71.0	27.2	71.9	27.6	72.8	28.0	73.8	28.3	74.7	28.7	75.6	29.0	76.6	29.4	77.5	29.7	69
22	70.5	28.5	71.4	28.8	72.3	29.2	73.2	29.6	74.2	30.0	75.1	30.3	76.0	30.7	77.0	31.1	68
23	70.0	29.7	70.9	30.1	71.8	30.5	72.7	30.9	73.6	31.3	74.6	31.6	75.5	32.0	76.4	32.4	67
24	69.4	30.9	70.3	31.3	71.3	31.7	72.2	32.1	73.1	32.5	74.0	32.9	74.9	33.4	75.8	33.8	66
25	68.9	32.1	69.8	32.5	70.7	33.0	71.6	33.4	72.5	33.8	73.4	34.2	74.3	34.7	75.2	35.1	65
26	68.3	33.3	69.2	33.8	70.1	34.2	71.0	34.6	71.9	35.1	72.8	35.5	73.7	35.9	74.6	36.4	64
27	67.7	34.5	68.6	35.0	69.5	35.4	70.4	35.9	71.3	36.3	72.2	36.8	73.1	37.2	74.0	37.7	63
28	67.1	35.7	68.0	36.1	68.9	36.6	69.8	37.1	70.6	37.6	71.5	38.0	72.4	38.5	73.3	39.0	62
29	66.5	36.8	67.3	37.3	68.2	37.8	69.1	38.3	70.0	38.8	70.8	39.3	71.7	39.8	72.6	40.2	61
30	65.8	38.0	66.7	38.5	67.5	39.0	68.4	39.5	69.3	40.0	70.1	40.5	71.0	41.0	71.9	41.5	60
31	65.1	39.1	66.0	39.7	66.9	40.2	67.7	40.7	68.6	41.2	69.4	41.7	70.3	42.2	71.1	42.7	59
32	64.5	40.3	65.3	40.8	66.1	41.3	67.0	41.9	67.8	42.4	68.7	42.9	69.5	43.5	70.4	44.0	58
33	63.7	41.4	64.6	41.9	65.4	42.5	66.3	43.0	67.1	43.6	67.9	44.1	68.8	44.7	69.6	45.2	57
34	63.0	42.5	63.8	43.1	64.7	43.6	65.5	44.2	66.3	44.7	67.2	45.3	68.0	45.9	68.8	46.4	56
35	62.3	43.6	63.1	44.2	63.9	44.7	64.7	45.3	65.5	45.9	66.4	46.5	67.2	47.0	68.0	47.6	55
36	61.5	44.7	62.3	45.3	63.1	45.8	63.9	46.4	64.7	47.0	65.5	47.6	66.3	48.2	67.1	48.8	54
37	60.7	45.7	61.5	46.3	62.3	46.9	63.1	47.5	63.9	48.1	64.7	48.7	65.5	49.3	66.3	50.0	53
38	59.9	46.8	60.7	47.4	61.5	48.0	62.3	48.6	63.0	49.3	63.8	49.9	64.6	50.5	65.4	51.1	52
39	59.1	47.8	59.8	48.5	60.6	49.1	61.4	49.7	62.2	50.3	62.9	51.0	63.7	51.6	64.5	52.2	51
40	58.2	48.9	59.0	49.5	59.8	50.1	60.5	50.8	61.3	51.4	62.0	52.1	62.8	52.7	63.6	53.4	50
41	57.4	49.9	58.1	50.5	58.9	51.2	59.6	51.8	60.4	52.5	61.1	53.1	61.9	53.8	62.6	54.5	49
42	56.5	50.9	57.2	51.5	58.0	52.2	58.7	52.9	59.5	53.5	60.2	54.2	60.9	54.9	61.7	55.5	48
43	55.6	51.8	56.3	52.5	57.0	53.2	57.8	53.9	58.5	54.6	59.2	55.2	60.0	55.9	60.7	56.6	47
44	54.7	52.8	55.4	53.5	56.1	54.2	56.8	54.9	57.5	55.6	58.3	56.3	59.0	57.0	59.7	57.7	46
45	53.7	53.7	54.4	54.4	55.2	55.2	55.9	55.9	56.6	56.6	57.3	57.3	58.0	58.0	58.7	58.7	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	D = 76′		D = 77′		D = 78′		D = 79′		D = 80′		D = 81′		D = 82′		D = 83′		

Plane Traverse Table

Course.	D=84′		D=85′		D=86′		D=87′		D=88′		D=89′		D=90′		D=91′		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	84.0	0.0	85.0	0.0	86.0	0.0	87.0	0.0	88.0	0.0	89.0	0.0	90.0	0.0	91.0	0.0	90
1	84.0	1.5	85.0	1.5	86.0	1.5	87.0	1.5	88.0	1.5	89.0	1.6	90.0	1.6	91.0	1.6	89
2	83.9	2.9	84.9	3.0	85.9	3.0	86.9	3.0	87.9	3.1	88.9	3.1	89.9	3.1	90.9	3.2	88
3	83.9	4.4	84.9	4.4	85.9	4.5	86.9	4.6	87.9	4.6	88.9	4.7	89.9	4.7	90.9	4.8	87
4	83.8	5.9	84.8	5.9	85.8	6.0	86.8	6.1	87.8	6.1	88.8	6.2	89.8	6.3	90.8	6.3	86
5	83.7	7.3	84.7	7.4	85.7	7.5	86.7	7.6	87.7	7.7	88.7	7.8	89.7	7.8	90.7	7.9	85
6	83.5	8.8	84.5	8.9	85.5	9.0	86.5	9.1	87.5	9.2	88.5	9.3	89.5	9.4	90.5	9.5	84
7	83.4	10.2	84.4	10.4	85.4	10.5	86.4	10.6	87.3	10.7	88.3	10.8	89.3	11.0	90.3	11.1	83
8	83.2	11.7	84.2	11.8	85.2	12.0	86.2	12.1	87.1	12.2	88.1	12.4	89.1	12.5	90.1	12.7	82
9	83.0	13.1	84.0	13.3	84.9	13.5	85.9	13.6	86.9	13.8	87.9	13.9	88.9	14.1	89.9	14.2	81
10	82.7	14.6	83.7	14.8	84.7	14.9	85.7	15.1	86.7	15.3	87.6	15.5	88.6	15.6	89.6	15.8	80
11	82.5	16.0	83.4	16.2	84.4	16.4	85.4	16.6	86.4	16.8	87.4	17.0	88.3	17.2	89.3	17.4	79
12	82.2	17.5	83.1	17.7	84.1	17.9	85.1	18.1	86.1	18.3	87.1	18.5	88.0	18.7	89.0	18.9	78
13	81.8	18.9	82.8	19.1	83.8	19.3	84.8	19.6	85.7	19.8	86.7	20.0	87.7	20.2	88.7	20.5	77
14	81.5	20.3	82.5	20.6	83.4	20.8	84.4	21.0	85.4	21.3	86.4	21.5	87.3	21.8	88.3	22.0	76
15	81.1	21.7	82.1	22.0	83.1	22.3	84.0	22.5	85.0	22.8	86.0	23.0	86.9	23.3	87.9	23.6	75
16	80.7	23.2	81.7	23.4	82.7	23.7	83.6	24.0	84.6	24.3	85.6	24.5	86.5	24.8	87.5	25.1	74
17	80.3	24.6	81.3	24.9	82.2	25.1	83.2	25.4	84.2	25.7	85.1	26.0	86.1	26.3	87.0	26.6	73
18	79.9	26.0	80.8	26.3	81.8	26.6	82.7	26.9	83.7	27.2	84.6	27.5	85.6	27.8	86.5	28.1	72
19	79.4	27.3	80.4	27.7	81.3	28.0	82.3	28.3	83.2	28.7	84.2	29.0	85.1	29.3	86.0	29.6	71
20	78.9	28.7	79.9	29.1	80.8	29.4	81.8	29.8	82.7	30.1	83.6	30.4	84.6	30.8	85.5	31.1	70
21	78.4	30.1	79.4	30.5	80.3	30.8	81.2	31.2	82.2	31.5	83.1	31.9	84.0	32.3	85.0	32.6	69
22	77.9	31.5	78.8	31.8	79.7	32.2	80.7	32.6	81.6	33.0	82.5	33.3	83.4	33.7	84.4	34.1	68
23	77.3	32.8	78.2	33.2	79.2	33.6	80.1	34.0	81.0	34.4	81.9	34.8	82.8	35.2	83.8	35.6	67
24	76.7	34.2	77.7	34.6	78.6	35.0	79.5	35.4	80.4	35.8	81.3	36.2	82.2	36.6	83.1	37.0	66
25	76.1	35.5	77.0	35.9	77.9	36.3	78.8	36.8	79.8	37.2	80.7	37.6	81.6	38.0	82.5	38.5	65
26	75.5	36.8	76.4	37.3	77.3	37.7	78.2	38.1	79.1	38.6	80.0	39.0	80.9	39.5	81.8	39.9	64
27	74.8	38.1	75.7	38.6	76.6	39.0	77.5	39.5	78.4	40.0	79.3	40.4	80.2	40.9	81.1	41.3	63
28	74.2	39.4	75.1	39.9	75.9	40.4	76.8	40.8	77.7	41.3	78.6	41.8	79.5	42.3	80.3	42.7	62
29	73.5	40.7	74.3	41.2	75.2	41.7	76.1	42.2	77.0	42.7	77.8	43.1	78.7	43.6	79.6	44.1	61
30	72.7	42.0	73.6	42.5	74.5	43.0	75.3	43.5	76.2	44.0	77.1	44.5	77.9	45.0	78.8	45.5	60
31	72.0	43.3	72.9	43.8	73.7	44.3	74.6	44.8	75.4	45.3	76.3	45.8	77.1	46.4	78.0	46.9	59
32	71.2	44.5	72.1	45.0	72.9	45.6	73.8	46.1	74.6	46.6	75.5	47.2	76.3	47.7	77.2	48.2	58
33	70.4	45.7	71.3	46.3	72.1	46.8	73.0	47.4	73.8	47.9	74.6	48.5	75.5	49.0	76.3	49.6	57
34	69.6	47.0	70.5	47.5	71.3	48.1	72.1	48.6	73.0	49.2	73.8	49.8	74.6	50.3	75.4	50.9	56
35	68.8	48.2	69.6	48.8	70.4	49.3	71.3	49.9	72.1	50.5	72.9	51.0	73.7	51.6	74.5	52.2	55
36	68.0	49.4	68.8	50.0	69.6	50.5	70.4	51.1	71.2	51.7	72.0	52.3	72.8	52.9	73.6	53.5	54
37	67.1	50.6	67.9	51.2	68.7	51.8	69.5	52.4	70.3	53.0	71.1	53.6	71.9	54.2	72.7	54.8	53
38	66.2	51.7	67.0	52.3	67.8	52.9	68.6	53.6	69.3	54.2	70.1	54.8	70.9	55.4	71.7	56.0	52
39	65.3	52.9	66.1	53.5	66.8	54.1	67.6	54.8	68.4	55.4	69.2	56.0	69.9	56.6	70.7	57.3	51
40	64.3	54.0	65.1	54.6	65.9	55.3	66.6	55.9	67.4	56.6	68.2	57.2	68.9	57.9	69.7	58.5	50
41	63.4	55.1	64.2	55.8	64.9	56.4	65.7	57.1	66.4	57.7	67.2	58.4	67.9	59.0	68.7	59.7	49
42	62.4	56.2	63.2	56.9	63.9	57.5	64.7	58.2	65.4	58.9	66.1	59.6	66.9	60.2	67.6	60.9	48
43	61.4	57.3	62.2	58.0	62.9	58.7	63.6	59.3	64.4	60.0	65.1	60.7	65.8	61.4	66.6	62.1	47
44	60.4	58.4	61.1	59.0	61.9	59.7	62.6	60.4	63.3	61.1	64.0	61.8	64.7	62.5	65.5	63.2	46
45	59.4	59.4	60.1	60.1	60.8	60.8	61.5	61.5	62.2	62.2	62.9	62.9	63.6	63.6	64.3	64.3	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	D=84′		D=85′		D=86′		D=87′		D=88′		D=89′		D=90′		D=91′		

Plane Traverse Table

Course.	D=92′		D=93′		D=94′		D=95′		D=96′		D=97′		D=98′		D=99′		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	92.0	0.0	93.0	0.0	94.0	0.0	95.0	0.0	96.0	0.0	97.0	0.0	98.0	0.0	99.0	0.0	90
1	92.0	1.6	93.0	1.6	94.0	1.6	95.0	1.7	96.0	1.7	97.0	1.7	98.0	1.7	99.0	1.7	89
2	91.9	3.2	92.9	3.2	93.9	3.3	94.9	3.3	95.9	3.4	96.9	3.4	97.9	3.4	98.9	3.5	88
3	91.9	4.8	92.9	4.9	93.9	4.9	94.9	5.0	95.9	5.0	96.9	5.1	97.9	5.1	98.9	5.2	87
4	91.8	6.4	92.8	6.5	93.8	6.6	94.8	6.6	95.8	6.7	96.8	6.8	97.8	6.8	98.8	6.9	86
5	91.6	8.0	92.6	8.1	93.6	8.2	94.6	8.3	95.6	8.4	96.6	8.5	97.6	8.5	98.6	8.6	85
6	91.5	9.6	92.5	9.7	93.5	9.8	94.5	9.9	95.5	10.0	96.5	10.1	97.5	10.2	98.5	10.3	84
7	91.3	11.2	92.3	11.3	93.3	11.5	94.3	11.6	95.3	11.7	96.3	11.8	97.3	11.9	98.3	12.1	83
8	91.1	12.8	92.1	12.9	93.1	13.1	94.1	13.2	95.1	13.4	96 1	13.5	97.0	13.6	98.0	13.8	82
9	90.9	14.4	91.9	14.5	92.8	14.7	93.8	14.9	94.8	15.0	95.8	15.2	96.8	15.3	97.8	15.5	81
10	90.6	16.0	91.6	16.1	92.6	16.3	93.6	16.5	94.5	16.7	95.5	16.8	96.5	17.0	97.5	17.2	80
11	90.3	17.6	91.3	17.7	92.3	17.9	93.3	18.1	94.2	18.3	95.2	18.5	96.2	18.7	97.2	18.9	79
12	90.0	19.1	91.0	19.3	91.9	19.5	92.9	19.8	93.9	20.0	94.9	20.2	95.9	20.4	96.8	20.6	78
13	89.6	20.7	90.6	20.9	91.6	21.1	92.6	21.4	93.5	21.6	94.5	21.8	95.5	22.0	96.5	22.3	77
14	89.3	22.3	90.2	22.5	91.2	22.7	92.2	23.0	93.1	23.2	94.1	23.5	95.1	23.7	96.1	24.0	76
15	88.9	23.8	89.8	24.1	90.8	24.3	91.8	24.6	92.7	24.8	93.7	25.1	94.7	25.4	95.6	25.6	75
16	88.4	25.4	89.4	25.6	90.4	25.9	91.3	26.2	92.3	26.5	93.2	26.7	94.2	27.0	95.2	27.3	74
17	88.0	26.9	88.9	27.2	89.9	27.5	90.8	27.8	91.8	28.1	92.8	28.4	93.7	28.7	94.7	28.9	73
18	87.5	28.4	88.4	28.7	89.4	29.0	90.4	29.4	91.3	29.7	92.3	30.0	93.2	30.3	94.2	30.6	72
19	87.0	30.0	87.9	30.3	88.9	30.6	89.8	30.9	90.8	31.3	91.7	31.6	92.7	31.9	93.6	32.2	71
20	86.5	31.5	87.4	31.8	88.3	32.1	89.3	32.5	90.2	32.8	91.2	33.2	92.1	33.5	93.0	33.9	70
21	85.9	33.0	86.8	33.3	87.8	33.7	88.7	34.0	89.6	34.4	90.6	34.8	91.5	35.1	92.4	35.5	69
22	85.3	34.5	86.2	34.8	87.2	35.2	88.1	35.6	89.0	36.0	89.9	36.3	90.9	36.7	91.8	37.1	68
23	84.7	35.9	85.6	36.3	86.5	36.7	87.4	37.1	88.4	37.5	89.3	37.9	90.2	38.3	91.1	38.7	67
24	84.0	37.4	85.0	37.8	85.9	38.2	86.8	38.6	87.7	39.0	88.6	39.5	89.5	39.9	90.4	40.3	66
25	83.4	38.9	84.3	39.3	85.2	39.7	86.1	40.1	87.0	40.6	87.9	41.0	88.8	41.4	89.7	41.8	65
26	82.7	40.3	83.6	40.8	84.5	41.2	85.4	41.6	86.3	42.1	87.2	42.5	88.1	43.0	89.0	43.4	64
27	82.0	41.8	82.9	42.2	83.8	42.7	84.6	43.1	85.5	43.6	86.4	44.0	87.3	44.5	88.2	44.9	63
28	81.2	43.2	82.1	43.7	83.0	44.1	83.9	44.6	84.8	45.1	85.6	45.5	86.5	46.0	87.4	46.5	62
29	80.5	44.6	81.3	45.1	82.2	45.6	83.1	46.1	84.0	46.5	84.8	47.0	85.7	47.5	86.6	48.0	61
30	79.7	46.0	80.5	46.5	81.4	47.0	82.3	47.5	83.1	48.0	84.0	48.5	84.9	49.0	85.7	49.5	60
31	78.9	47.4	79.7	47.9	80.6	48.4	81.4	48.9	82.3	49.4	83.1	50.0	84.0	50.5	84.9	51.0	59
32	78.0	48.8	78.9	49.3	79.7	49.8	80.6	50.3	81.4	50.9	82.3	51.4	83.1	51.9	84.0	52.5	58
33	77.2	50.1	78.0	50.7	78.8	51.2	79.7	51.7	80.5	52.3	81.4	52.8	82.2	53.4	83.0	53.9	57
34	76.3	51.4	77.1	52.0	77.9	52.6	78.8	53.1	79.6	53.7	80.4	54.2	81.2	54.8	82.1	55.4	56
35	75.4	52.8	76.2	53.3	77.0	53.9	77.8	54.5	78.6	55.1	79.5	55.6	80.3	56.2	81.1	56.8	55
36	74.4	54.1	75.2	54.7	76.0	55.3	76.9	55.8	77.7	56.4	78.5	57.0	79.3	57.6	80.1	58.2	54
37	73.5	55.4	74.3	56.0	75.1	56.6	75.9	57.2	76.7	57.8	77.5	58.4	78.3	59.0	79.1	59.6	53
38	72.5	56.6	73.3	57.3	74.1	57.9	74.9	58.5	75.6	59.1	76.4	59.7	77.2	60.3	78.0	61.0	52
39	71.5	57.9	72.3	58.5	73.1	59.2	73.8	59.8	74.6	60.4	75.4	61.0	76.2	61.7	76.9	62.3	51
40	70.5	59.1	71.2	59.8	72.0	60.4	72.8	61.1	73.5	61.7	74.3	62.4	75.1	63.0	75.8	63.6	50
41	69.4	60.4	70.2	61.0	70.9	61.7	71.7	62.3	72.5	63.0	73.2	63.6	74.0	64.3	74.7	64.9	49
42	68.4	61.6	69.1	62.2	69.9	62.9	70.6	63.6	71.3	64.2	72.1	64.9	72.8	65.6	73.6	66.2	48
43	67.3	62.7	68.0	63.4	68.7	64.1	69.5	64.8	70.2	65.5	70.9	66.2	71.7	66.8	72.4	67.5	47
44	66.2	63.9	66.9	64.6	67.6	65.3	68.3	66.0	69.1	66.7	69.8	67.4	70.5	68.1	71.2	68.8	46
45	65.1	65.1	65.8	65.8	66.5	66.5	67.2	67.2	67.9	67.9	68.6	68.6	69.3	69.3	70.0	70.0	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	D=92′		D=93′		D=94′		D=95′		D=96′		D=97′		D=98′		D=99′		

Plane Traverse Table

Course.	D = 100′		D = 101′		D = 102′		D = 103′		D = 104′		D = 105′		D = 106′		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	100.0	0.0	101.0	0.0	102.0	0.0	103.0	0.0	104.0	0.0	105.0	0.0	106.0	0.0	90
1	100.0	1.7	101.0	1.8	102.0	1.8	103.0	1.8	104.0	1.8	105.0	1.8	106.0	1.8	89
2	99.9	3.5	100.9	3.5	101.9	3.6	102.9	3.6	103.9	3.6	104.9	3.7	105.9	3.7	88
3	99.9	5.2	100.9	5.3	101.9	5.3	102.9	5.4	103.9	5.4	104.9	5.5	105.9	5.5	87
4	99.8	7.0	100.8	7.0	101.8	7.1	102.7	7.2	103.7	7.3	104.7	7.3	105.7	7.4	86
5	99.6	8.7	100.6	8.8	101.6	8.9	102.6	9.0	103.6	9.1	104.6	9.2	105.6	9.2	85
6	99.5	10.5	100.4	10.6	101.4	10.7	102.4	10.8	103.4	10.9	104.4	11.0	105.4	11.1	84
7	99.3	12.2	100.2	12.3	101.2	12.4	102.2	12.6	103.2	12.7	104.2	12.8	105.2	12.9	83
8	99.0	13.9	100.0	14.1	101.0	14.2	102.0	14.3	103.0	14.5	104.0	14.6	105.0	14.8	82
9	98.8	15.6	99.8	15.8	100.7	16.0	101.7	16.1	102.7	16.3	103.7	16.4	104.7	16.6	81
10	98.5	17.4	99.5	17.5	100.5	17.7	101.4	17.9	102.4	18.1	103.4	18.2	104.4	18.4	80
11	98.2	19.1	99.1	19.3	100.1	19.5	101.1	19.7	102.1	19.8	103.1	20.0	104.1	20.2	79
12	97.8	20.8	98.8	21.0	99.8	21.2	100.7	21.4	101.7	21.6	102.7	21.8	103.7	22.0	78
13	97.4	22.5	98.4	22.7	99.4	22.9	100.4	23.2	101.3	23.4	102.3	23.6	103.3	23.8	77
14	97.0	24.2	98.0	24.4	99.0	24.7	99.9	24.9	100.9	25.2	101.9	25.4	102.9	25.6	76
15	96.6	25.9	97.6	26.1	98.5	26.4	99.5	26.7	100.5	26.9	101.4	27.2	102.4	27.4	75
16	96.1	27.6	97.1	27.8	98.0	28.1	99.0	28.4	100.0	28.7	100.9	28.9	101.9	29.2	74
17	95.6	29.2	96.6	29.5	97.5	29.8	98.5	30.1	99.5	30.4	100.4	30.7	101.4	31.0	73
18	95.1	30.9	96.1	31.2	97.0	31.5	98.0	31.8	98.9	32.1	99.9	32.4	100.8	32.8	72
19	94.6	32.6	95.5	32.9	96.4	33.2	97.4	33.5	98.3	33.9	99.3	34.2	100.2	34.5	71
20	94.0	34.2	94.9	34.5	95.8	34.9	96.8	35.2	97.7	35.6	98.7	35.9	99.6	36.3	70
21	93.4	35.8	94.3	36.2	95.2	36.6	96.2	36.9	97.1	37.3	98.0	37.6	99.0	38.0	69
22	92.7	37.5	93.6	37.8	94.6	38.2	95.5	38.6	96.4	39.0	97.4	39.3	98.3	39.7	68
23	92.1	39.1	93.0	39.5	93.9	39.9	94.8	40.2	95.7	40.6	96.7	41.0	97.6	41.4	67
24	91.4	40.7	92.3	41.1	93.2	41.5	94.1	41.9	95.0	42.3	95.9	42.7	96.8	43.1	66
25	90.6	42.3	91.5	42.7	92.4	43.1	93.3	43.5	94.3	44.0	95.2	44.4	96.1	44.8	65
26	89.9	43.8	90.8	44.3	91.7	44.7	92.6	45.2	93.5	45.6	94.4	46.0	95.3	46.5	64
27	89.1	45.4	90.0	45.9	90.9	46.3	91.8	46.8	92.7	47.2	93.6	47.7	94.4	48.1	63
28	88.3	46.9	89.2	47.4	90.1	47.9	90.9	48.4	91.8	48.8	92.7	49.3	93.6	49.8	62
29	87.5	48.5	88.3	49.0	89.2	49.5	90.1	49.9	91.0	50.4	91.8	50.9	92.7	51.4	61
30	86.6	50.0	87.5	50.5	88.3	51.0	89.2	51.5	90.1	52.0	90.9	52.5	91.8	53.0	60
31	85.7	51.5	86.6	52.0	87.4	52.5	88.3	53.0	89.1	53.6	90.0	54.1	90.9	54.6	59
32	84.8	53.0	85.7	53.5	86.5	54.1	87.3	54.6	88.2	55.1	89.0	55.6	89.9	56.2	58
33	83.9	54.5	84.7	55.0	85.5	55.6	86.4	56.1	87.2	56.6	88.1	57.2	88.9	57.7	57
34	82.9	55.9	83.7	56.5	84.6	57.0	85.4	57.6	86.2	58.2	87.0	58.7	87.9	59.3	56
35	81.9	57.4	82.7	57.9	83.6	58.5	84.4	59.1	85.2	59.7	86.0	60.2	86.8	60.8	55
36	80.9	58.8	81.7	59.4	82.5	60.0	83.3	60.5	84.1	61.1	84.9	61.7	85.8	62.3	54
37	79.9	60.2	80.7	60.8	81.5	61.4	82.3	62.0	83.1	62.6	83.9	63.2	84.7	63.8	53
38	78.8	61.6	79.6	62.2	80.4	62.8	81.2	63.4	82.0	64.0	82.7	64.6	83.5	65.3	52
39	77.7	62.9	78.5	63.6	79.3	64.2	80.0	64.8	80.8	65.4	81.6	66.1	82.4	66.7	51
40	76.6	64.3	77.4	64.9	78.1	65.6	78.9	66.2	79.7	66.8	80.4	67.5	81.2	68.1	50
41	75.5	65.6	76.2	66.3	77.0	66.9	77.7	67.6	78.5	68.2	79.2	68.9	80.0	69.5	49
42	74.3	66.9	75.1	67.6	75.8	68.3	76.5	68.9	77.3	69.6	78.0	70.3	78.8	70.9	48
43	73.1	68.2	73.9	68.9	74.6	69.6	75.3	70.2	76.1	70.9	76.8	71.6	77.5	72.3	47
44	71.9	69.5	72.7	70.2	73.4	70.9	74.1	71.5	74.8	72.2	75.5	72.9	76.3	73.6	46
45	70.7	70.7	71.4	71.4	72.1	72.1	72.8	72.8	73.5	73.5	74.2	74.2	75.0	75.0	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	D = 100′		D = 101′		D = 102′		D = 103′		D = 104′		D = 105′		D = 106′		

Plane Traverse Table

Course.	D = 107′		D = 108′		D = 109′		D = 110′		D = 111′		D = 112′		D = 113′		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	107.0	0.0	108.0	0.0	109.0	0.0	110.0	0.0	111.0	0.0	112.0	0.0	113.0	0.0	90
1	107.0	1.9	108.0	1.9	109.0	1.9	110.0	1.9	111.0	1.9	112.0	2.0	113.0	2.0	89
2	106.9	3.7	107.9	3.8	108.9	3.8	109.9	3.8	110.9	3.9	111.9	3.9	112.9	3.9	88
3	106.9	5.6	107.9	5.7	108.9	5.7	109.8	5.8	110.8	5.8	111.8	5.9	112.8	5.9	87
4	106.7	7.5	107.7	7.5	108.7	7.6	109.7	7.7	110.7	7.7	111.7	7.8	112.7	7.9	86
5	106.6	9.3	107.6	9.4	108.6	9.5	109.6	9.6	110.6	9.7	111.6	9.8	112.6	9.8	85
6	106.4	11.2	107.4	11.3	108.4	11.4	109.4	11.5	110.4	11.6	111.4	11.7	112.4	11.8	84
7	106.2	13.0	107.2	13.2	108.2	13.3	109.2	13.4	110.2	13.5	111.2	13.6	112.2	13.8	83
8	106.0	14.9	106.9	15.0	107.9	15.2	108.9	15.3	109.9	15.4	110.9	15.6	111.9	15.7	82
9	105.7	16.7	106.7	16.9	107.7	17.1	108.6	17.2	109.6	17.4	110.6	17.5	111.6	17.7	81
10	105.4	18.6	106.4	18.8	107.3	18.9	108.3	19.1	109.3	19.3	110.3	19.4	111.3	19.6	80
11	105.0	20.4	106.0	20.6	107.0	20.8	108.0	21.0	109.0	21.2	109.9	21.4	110.9	21.6	79
12	104.7	22.2	105.6	22.5	106.6	22.7	107.6	22.9	108.6	23.1	109.6	23.3	110.5	23.5	78
13	104.3	24.1	105.2	24.3	106.2	24.5	107.2	24.7	108.2	25.0	109.1	25.2	110.1	25.4	77
14	103.8	25.9	104.8	26.1	105.8	26.4	106.7	26.6	107.7	26.9	108.7	27.1	109.6	27.3	76
15	103.4	27.7	104.3	28.0	105.3	28.2	106.3	28.5	107.2	28.7	108.2	29.2	109.1	29.2	75
16	102.9	29.5	103.8	29.8	104.8	30.0	105.7	30.3	106.7	30.6	107.7	30.9	108.6	31.1	74
17	102.3	31.3	103.3	31.6	104.2	31.9	105.2	32.2	106.1	32.5	107.1	32.7	108.1	33.0	73
18	101.8	33.1	102.7	33.4	103.7	33.7	104.6	34.0	105.6	34.3	106.5	34.6	107.5	34.9	72
19	101.2	34.8	102.1	35.2	103.1	35.5	104.0	35.8	105.0	36.1	105.9	36.5	106.8	36.8	71
20	100.5	36.6	101.5	36.9	102.4	37.3	103.4	37.6	104.3	38.0	105.2	38.3	106.2	38.6	70
21	99.9	38.3	100.8	38.7	101.8	39.1	102.7	39.4	103.6	39.8	104.6	40.1	105.5	40.5	69
22	99.2	40.1	100.1	40.5	101.1	40.8	102.0	41.2	102.9	41.6	103.8	42.0	104.8	42.3	68
23	98.5	41.8	99.4	42.2	100.3	42.6	101.3	43.0	102.2	43.4	103.1	43.8	104.0	44.2	67
24	97.7	43.5	98.7	43.9	99.6	44.3	100.5	44.7	101.4	45.1	102.3	45.6	103.2	46.0	66
25	97.0	45.2	97.9	45.6	98.8	46.1	99.7	46.5	100.6	46.9	101.5	47.3	102.4	47.8	65
26	96.2	46.9	97.1	47.3	98.0	47.8	98.9	48.2	99.8	48.7	100.7	49.1	101.6	49.5	64
27	95.3	48.6	96.2	49.0	97.1	49.5	98.0	49.9	98.9	50.4	99.8	50.8	100.7	51.3	63
28	94.5	50.2	95.4	50.7	96.2	51.2	97.1	51.6	98.0	52.1	98.9	52.6	99.8	53.1	62
29	93.6	51.9	94.5	52.4	95.3	52.8	96.2	53.3	97.1	53.8	98.0	54.3	98.8	54.8	61
30	92.7	53.5	93.5	54.0	94.4	54.5	95.3	55.0	96.1	55.5	97.0	56.0	97.9	56.5	60
31	91.7	55.1	92.6	55.6	93.4	56.1	94.3	56.7	95.1	57.2	96.0	57.7	96.9	58.2	59
32	90.7	56.7	91.6	57.2	92.4	57.8	93.3	58.3	94.1	58.8	95.0	59.4	95.8	59.9	58
33	89.7	58.3	90.6	58.8	91.4	59.4	92.3	59.9	93.1	60.5	93.9	61.0	94.8	61.5	57
34	88.7	59.8	89.5	60.4	90.4	61.0	91.2	61.5	92.0	62.1	92.9	62.6	93.7	63.2	56
35	87.6	61.4	88.5	61.9	89.3	62.5	90.1	63.1	90.9	63.7	91.7	64.2	92.6	64.8	55
36	86.6	62.9	87.4	63.5	88.2	64.1	89.0	64.7	89.8	65.2	90.6	65.8	91.4	66.4	54
37	85.5	64.4	86.3	65.0	87.1	65.6	87.8	66.2	88.6	66.8	89.4	67.4	90.2	68.0	53
38	84.3	65.9	85.1	66.5	85.9	67.1	86.7	67.7	87.5	68.3	88.3	69.0	89.0	69.6	52
39	83.2	67.3	83.9	68.0	84.7	68.6	85.5	69.2	86.3	69.9	87.0	70.5	87.8	71.1	51
40	82.0	68.8	82.7	69.4	83.5	70.1	84.3	70.7	85.0	71.3	85.8	72.0	86.6	72.6	50
41	80.8	70.2	81.5	70.9	82.3	71.5	83.0	72.2	83.8	72.8	84.5	73.5	85.3	74.1	49
42	79.5	71.6	80.3	72.3	81.0	72.9	81.7	73.6	82.5	74.3	83.2	74.9	84.0	75.6	48
43	78.3	73.0	79.0	73.7	79.7	74.3	80.4	75.0	81.2	75.7	81.9	76.4	82.6	77.1	47
44	77.0	74.3	77.7	75.0	78.4	75.7	79.1	76.4	79.8	77.1	80.6	77.8	81.3	78.5	46
45	75.7	75.7	76.4	76.4	77.1	77.1	77.8	77.8	78.5	78.5	79.2	79.2	79.9	79.9	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	D = 107′		D = 108′		D = 109′		D = 110′		D = 111′		D = 112′		D = 113′		

Plane Traverse Table

Course.	$D=114'$		$D=115'$		$D=116'$		$D=117'$		$D=118'$		$D=119'$		$D=120'$		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	114.0	0.0	115.0	0.0	116.0	0.0	117.0	0.0	118.0	0.0	119.0	0.0	120.0	0.0	90
1	114.0	2.0	115.0	2.0	116.0	2.0	117.0	2.0	118.0	2.1	119.0	2.1	120.0	2.1	89
2	113.9	4.0	114.9	4.0	115.9	4.0	116.9	4.1	117.9	4.1	118.9	4.2	119.9	4.2	88
3	113.8	6.0	114.8	6.0	115.8	6.1	116.8	6.1	117.8	6.2	118.8	6.2	119.8	6.3	87
4	113.7	8.0	114.7	8.0	115.7	8.1	116.7	8.2	117.7	8.2	118.7	8.3	119.7	8.4	86
5	113.6	9.9	114.6	10.0	115.6	10.1	116.6	10.2	117.6	10.3	118.5	10.4	119.5	10.5	85
6	113.4	11.9	114.4	12.0	115.4	12.1	116.4	12.2	117.4	12.3	118.3	12.4	119.3	12.5	84
7	113.2	13.9	114.1	14.0	115.1	14.1	116.1	14.3	117.1	14.4	118.1	14.5	119.1	14.6	83
8	112.9	15.9	113.9	16.0	114.9	16.1	115.9	16.3	116.9	16.4	117.8	16.6	118.8	16.7	82
9	112.6	17.8	113.6	18.0	114.6	18.1	115.6	18.3	116.5	18.5	117.5	18.6	118.5	18.8	81
10	112.3	19.8	113.3	20.0	114.2	20.1	115.2	20.3	116.2	20.5	117.2	20.7	118.2	20.8	80
11	111.9	21.8	112.9	21.9	113.9	22.1	114.9	22.3	115.8	22.5	116.8	22.7	117.8	22.9	79
12	111.5	23.7	112.5	23.9	113.5	24.1	114.4	24.3	115.4	24.5	116.4	24.7	117.4	24.9	78
13	111.1	25.6	112.1	25.9	113.0	26.1	114.0	26.3	115.0	26.5	116.0	26.8	116.9	27.0	77
14	110.6	27.6	111.6	27.8	112.6	28.1	113.5	28.3	114.5	28.5	115.5	28.8	116.4	29.0	76
15	110.1	29.5	111.1	29.8	112.0	30.0	113.0	30.3	114.0	30.5	114.9	30.8	115.9	31.1	75
16	109.6	31.4	110.5	31.7	111.5	32.0	112.5	32.2	113.4	32.5	114.4	32.8	115.4	33.1	74
17	109.0	33.3	110.0	33.6	110.9	33.9	111.9	34.2	112.8	34.5	113.8	34.8	114.8	35.1	73
18	108.4	35.2	109.4	35.5	110.3	35.8	111.3	36.2	112.2	36.5	113.2	36.8	114.1	37.1	72
19	107.8	37.1	108.7	37.4	109.7	37.8	110.6	38.1	111.6	38.4	112.5	38.7	113.5	39.1	71
20	107.1	39.0	108.1	39.3	109.0	39.7	109.9	40.0	110.9	40.4	111.8	40.7	112.8	41.0	70
21	106.4	40.9	107.4	41.2	108.3	41.6	109.2	41.9	110.2	42.3	111.1	42.6	112.0	43.0	69
22	105.7	42.7	106.6	43.1	107.6	43.5	108.5	43.8	109.4	44.2	110.3	44.6	111.3	45.0	68
23	104.9	44.5	105.9	44.9	106.8	45.3	107.7	45.7	108.6	46.1	109.5	46.5	110.5	46.9	67
24	104.1	46.4	105.1	46.8	106.0	47.2	106.9	47.6	107.8	48.0	108.7	48.4	109.6	48.8	66
25	103.3	48.2	104.2	48.6	105.1	49.0	106.0	49.4	106.9	49.9	107.9	50.3	108.8	50.7	65
26	102.5	50.0	103.4	50.4	104.3	50.9	105.2	51.3	106.1	51.7	107.0	52.2	107.9	52.6	64
27	101.6	51.8	102.5	52.2	103.4	52.7	104.2	53.1	105.1	53.6	106.0	54.0	106.9	54.5	63
28	100.7	53.5	101.5	54.0	102.4	54.5	103.3	54.9	104.2	55.4	105.1	55.9	106.0	56.3	62
29	99.7	55.3	100.6	55.8	101.5	56.2	102.3	56.7	103.2	57.2	104.1	57:7	105.0	58.2	61
30	98.7	57.0	99.6	57.5	100.5	58.0	101.3	58.5	102.2	59.0	103.1	59.5	103.9	60.0	60
31	97.7	58.7	98.6	59.2	99.4	59.7	100.3	60.3	101.1	60.8	102.0	61.3	102.9	61.8	59
32	96.7	60.4	97.5	60.9	98.4	61.5	99.2	62.0	100.1	62.5	100.9	63.1	101.8	63.6	58
33	95.6	62.1	96.4	62.6	97.3	63.2	98.1	63.7	99.0	64.3	99.8	64.8	100.6	65.4	57
34	94.5	63.7	95.3	64.3	96.2	64.9	97.0	65.4	97.8	66.0	98.7	66.5	99.5	67.1	56
35	93.4	65.4	94.2	66.0	95.0	66.5	95.8	67.1	96.7	67.7	97.5	68.3	98.3	68.8	55
36	92.2	67.0	93.0	67.6	93.8	68.2	94.7	68.8	95.5	69.4	96.3	69.9	97.1	70.5	54
37	91.0	68.6	91.8	69.2	92.6	69.8	93.4	70.4	94.2	71.0	95.0	71.6	95.8	72.2	53
38	89.8	70.2	90.6	70.8	91.4	71.4	92.2	72.0	93.0	72.6	93.8	73.3	94.6	73.9	52
39	88.6	71.7	89.4	72.4	90.1	73.0	90.9	73.6	91.7	74.2	92.5	74.9	93.3	75.5	51
40	87.3	73.3	88.1	73.9	88.9	74.6	89.6	75.2	90.4	75.8	91.2	76.5	91.9	77.1	50
41	86.0	74.8	86.8	75.4	87.5	76.1	88.3	76.8	89.1	77.4	89.8	78.1	90.6	78.7	49
42	84.7	76.3	85.5	77.0	86.2	77.6	86.9	78.3	87.7	79.0	88.4	79.6	89.2	80.3	48
43	83.4	77.7	84.1	78.4	84.8	79.1	85.6	79.8	86.3	80.5	87.0	81.2	87.8	81.8	47
44	82.0	79.2	82.7	79.9	83.4	80.6	84.2	81.3	84.9	82.0	85.6	82.7	86.3	83.4	46
45	80.6	80.6	81.3	81.3	82.0	82.0	82.7	82.7	83.4	83.4	84.1	84.1	84.9	84.9	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	$D=114'$		$D=115'$		$D=116'$		$D=117'$		$D=118'$		$D=119'$		$D=120'$		

Plane Traverse Table

Course.	$D=121'$		$D=122'$		$D=123'$		$D=124'$		$D=125'$		$D=126'$		$D=127'$		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	121.0	0.0	122.0	0.0	123.0	0.0	124.0	0.0	125.0	0.0	126.0	0.0	127.0	0.0	90
1	121.0	2.1	122.0	2.1	123.0	2.1	124.0	2.2	125.0	2.2	126.0	2.2	127.0	2.2	89
2	120.9	4.2	121.9	4.3	122.9	4.3	123.9	4.3	124.9	4.4	125.9	4.4	126.9	4.4	88
3	120.8	6.3	121.8	6.4	122.8	6.4	123.8	6.5	124.8	6.5	125.8	6.6	126.8	6.6	87
4	120.7	8.4	121.7	8.5	122.7	8.6	123.7	8.6	124.7	8.7	125.7	8.8	126.7	8.9	86
5	120.5	10.5	121.5	10.6	122.5	10.7	123.5	10.8	124.5	10.9	125.5	11.0	126.5	11.1	85
6	120.3	12.6	121.3	12.8	122.3	12.9	123.3	13.0	124.3	13.1	125.3	13.2	126.3	13.3	84
7	120.1	14.7	121.1	14.9	122.1	15.0	123.1	15.1	124.1	15.2	125.1	15.4	126.1	15.5	83
8	119.8	16.8	120.8	17.0	121.8	17.1	122.8	17.3	123.8	17.4	124.8	17.5	125.8	17.7	82
9	119.5	18.9	120.5	19.1	121.5	19.2	122.5	19.4	123.5	19.6	124.4	19.7	125.4	19.9	81
10	119.2	21.0	120.1	21.2	121.1	21.4	122.1	21.5	123.1	21.7	124.1	21.9	125.1	22.1	80
11	118.8	23.1	119.8	23.3	120.7	23.5	121.7	23.7	122.7	23.9	123.7	24.0	124.7	24.2	79
12	118.4	25.2	119.3	25.4	120.3	25.6	121.3	25.8	122.3	26.0	123.2	26.2	124.2	26.4	78
13	117.9	27.2	118.9	27.4	119.8	27.7	120.8	27.9	121.8	28.1	122.8	28.3	123.7	28.6	77
14	117.4	29.3	118.4	29.5	119.3	29.8	120.3	30.0	121.3	30.2	122.3	30.5	123.2	30.7	76
15	116.9	31.3	117.8	31.6	118.8	31.8	119.8	32.1	120.7	32.4	121.7	32.6	122.7	32.9	75
16	116.3	33.4	117.3	33.6	118.2	33.9	119.2	34.2	120.2	34.5	121.1	34.7	122.1	35.0	74
17	115.7	35.4	116.7	35.7	117.6	36.0	118.6	36.3	119.5	36.5	120.5	36.8	121.5	37.1	73
18	115.1	37.4	116.0	37.7	117.0	38.0	117.9	38.3	118.9	38.6	119.8	38.9	120.8	39.2	72
19	114.4	39.4	115.4	39.7	116.3	40.0	117.2	40.4	118.2	40.7	119.1	41.0	120.1	41.3	71
20	113.7	41.4	114.6	41.7	115.6	42.1	116.5	42.4	117.5	42.8	118.4	43.1	119.3	43.4	70
21	113.0	43.4	113.9	43.7	114.8	44.1	115.8	44.4	116.7	44.8	117.6	45.2	118.6	45.5	69
22	112.2	45.3	113.1	45.7	114.0	46.1	115.0	46.5	115.9	46.8	116.8	47.2	117.8	47.6	68
23	111.4	47.3	112.3	47.7	113.2	48.1	114.1	48.5	115.1	48.8	116.0	49.2	116.9	49.6	67
24	110.5	49.2	111.5	49.6	112.4	50.0	113.3	50.4	114.2	50.8	115.1	51.2	116.0	51.7	66
25	109.7	51.1	110.6	51.6	111.5	52.0	112.4	52.4	113.3	52.8	114.2	53.2	115.1	53.7	65
26	108.8	53.0	109.7	53.5	110.6	53.9	111.5	54.4	112.3	54.8	113.2	55.2	114.1	55.7	64
27	107.8	54.9	108.7	55.4	109.6	55.8	110.5	56.3	111.4	56.7	112.3	57.2	113.2	57.7	63
28	106.8	56.8	107.7	57.3	108.6	57.7	109.5	58.2	110.4	58.7	111.3	59.2	112.1	59.6	62
29	105.8	58.7	106.7	59.1	107.6	59.6	108.5	60.1	109.3	60.6	110.2	61.1	111.1	61.6	61
30	104.8	60.5	105.7	61.0	106.5	61.5	107.4	62.0	108.3	62.5	109.1	63.0	111.0	63.5	60
31	103.7	62.3	104.6	62.8	105.4	63.3	106.3	63.9	107.1	64.4	108.0	64.9	108.9	65.4	59
32	102.6	64.1	103.5	64.7	104.3	65.2	105.2	65.7	106.0	66.2	106.9	66.8	107.7	67.3	58
33	101.5	65.9	102.3	66.4	103.2	67.0	104.0	67.5	104.8	68.1	105.7	68.6	106.5	69.2	57
34	100.3	67.7	101.1	68.2	102.0	68.8	102.8	69.3	103.6	69.9	104.5	70.5	105.3	71.0	56
35	99.1	69.4	99.9	70.0	100.8	70.5	101.6	71.1	102.4	71.7	103.2	72.3	104.0	72.8	55
36	97.9	71.1	98.7	71.7	99.5	72.3	100.3	72.9	101.1	73.5	101.9	74.1	102.7	74.6	54
37	96.6	72.8	97.4	73.4	98.2	74.0	99.0	74.6	99.8	75.2	100.6	75.8	101.4	76.4	53
38	95.3	74.5	96.1	75.1	96.9	75.7	97.7	76.3	98.5	77.0	99.3	77.6	100.1	78.2	52
39	94.0	76.1	94.8	76.8	95.6	77.4	96.4	78.0	97.1	78.7	97.9	79.3	98.7	79.9	51
40	92.7	77.8	93.5	78.4	94.2	79.1	95.0	79.7	95.8	80.3	96.5	81.0	97.3	81.6	50
41	91.3	79.4	92.1	80.0	92.8	80.7	93.6	81.4	94.3	82.0	95.1	82.7	95.8	83.3	49
42	89.9	81.0	90.7	81.6	91.4	82.3	92.1	83.0	92.9	83.6	93.6	84.3	94.4	85.0	48
43	88.5	82.5	89.2	83.2	90.0	83.9	90.7	84.6	91.4	85.2	92.2	85.9	92.9	86.6	47
44	87.0	84.1	87.8	84.7	88.5	85.4	89.2	86.1	89.9	86.8	90.6	87.5	91.4	88.2	46
45	85.6	85.6	86.3	86.3	87.0	87.0	87.7	87.7	88.4	88.4	89.1	89.1	89.8	89.8	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	$D=121'$		$D=122'$		$D=123'$		$D=124'$		$D=125'$		$D=126'$		$D=127'$		

Plane Traverse Table

Course.	$D=128'$		$D=129'$		$D=130'$		$D=131'$		$D=132'$		$D=133'$		$D=134'$		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	128.0	0.0	129.0	0.0	130.0	0.0	131.0	0.0	132.0	0.0	133.0	0.0	134.0	0.0	90
1	128.0	2.2	129.0	2.3	130.0	2.3	131.0	2.3	132.0	2.3	133.0	2.3	134.0	2.3	89
2	127.9	4.5	128.9	4.5	129.9	4.5	130.9	4.6	131.9	4.6	132.9	4.6	133.9	4.7	88
3	127.8	6.7	128.8	6.8	129.8	6.8	130.8	6.9	131.8	6.9	132.8	7.0	133.8	7.0	87
4	127.7	8.9	128.7	9.0	129.7	9.1	130.7	9.1	131.7	9.2	132.7	9.3	133.7	9.3	86
5	127.5	11.2	128.5	11.2	129.5	11.3	130.5	11.4	131.5	11.5	132.5	11.6	133.5	11.7	85
6	127.3	13.4	128.3	13.5	129.3	13.6	130.3	13.7	131.3	13.8	132.3	13.9	133.3	14.0	84
7	127.0	15.6	128.0	15.7	129.0	15.8	130.0	16.0	131.0	16.1	132.0	16.2	133.0	16.3	83
8	126.8	17.8	127.7	18.0	128.7	18.1	129.7	18.2	130.7	18.4	131.7	18.5	132.7	18.6	82
9	126.4	20.0	127.4	20.2	128.4	20.3	129.4	20.5	130.4	20.6	131.4	20.8	132.4	21.0	81
10	126.1	22.2	127.0	22.4	128.0	22.6	129.0	22.7	130.0	22.9	131.0	23.1	132.0	23.3	80
11	125.6	24.4	126.6	24.6	127.6	24.8	128.6	25.0	129.6	25.2	130.6	25.4	131.5	25.6	79
12	125.2	26.6	126.2	26.8	127.2	27.0	128.1	27.2	129.1	27.4	130.1	27.7	131.1	27.9	78
13	124.7	28.8	125.7	29.0	126.7	29.2	127.6	29.5	128.6	29.7	129.6	29.9	130.6	30.1	77
14	124.2	31.0	125.2	31.2	126.1	31.4	127.1	31.7	128.1	31.9	129.0	32.2	130.0	32.4	76
15	123.6	33.1	124.6	33.4	125.6	33.6	126.5	33.9	127.5	34.2	128.5	34.4	129.4	34.7	75
16	123.0	35.3	124.0	35.6	125.0	35.8	125.9	36.1	126.9	36.4	127.8	36.7	128.8	36.9	74
17	122.4	37.4	123.4	37.7	124.3	38.0	125.3	38.3	126.2	38.6	127.2	38.9	128.1	39.2	73
18	121.7	39.6	122.7	39.9	123.6	40.2	124.6	40.5	125.5	40.8	126.5	41.1	127.4	41.4	72
19	121.0	41.7	122.0	42.0	122.9	42.3	123.9	42.6	124.8	43.0	125.8	43.3	126.7	43.6	71
20	120.3	43.8	121.2	44.1	122.2	44.5	123.1	44.8	124.0	45.1	125.0	45.5	125.9	45.8	70
21	119.5	45.9	120.4	46.2	121.4	46.6	122.3	46.9	123.2	47.3	124.2	47.7	125.1	48.0	69
22	118.7	47.9	119.6	48.3	120.5	48.7	121.5	49.1	122.4	49.4	123.3	49.8	124.2	50.2	68
23	117.8	50.0	118.7	50.4	119.7	50.8	120.6	51.2	121.5	51.6	122.4	52.0	123.3	52.4	67
24	116.9	52.1	117.8	52.5	118.8	52.9	119.7	53.3	120.6	53.7	121.5	54.1	122.4	54.5	66
25	116.0	54.1	116.9	54.5	117.8	54.9	118.7	55.4	119.6	55.8	120.5	56.2	121.4	56.6	65
26	115.0	56.1	115.9	56.5	116.8	57.0	117.7	57.4	118.6	57.9	119.5	58.3	120.4	58.7	64
27	114.0	58.1	114.9	58.6	115.8	59.0	116.7	59.5	117.6	59.9	118.5	60.4	119.4	60.8	63
28	113.0	60.1	113.9	60.6	114.8	61.0	115.7	61.5	116.5	62.0	117.4	62.4	118.3	62.9	62
29	112.0	62.1	112.8	62.5	113.7	63.0	114.6	63.5	115.4	64.0	116.3	64.5	117.2	65.0	61
30	110.9	64.0	111.7	64.5	112.6	65.0	113.4	65.5	114.3	66.0	115.2	66.5	116.0	67.0	60
31	109.7	65.9	110.6	66.4	111.4	67.0	112.3	67.5	113.1	68.0	114.0	68.5	114.9	69.0	59
32	108.6	67.8	109.4	68.4	110.2	68.9	111.1	69.4	111.9	69.9	112.8	70.5	113.6	71.0	58
33	107.3	69.7	108.2	70.3	109.0	70.8	109.9	71.3	110.7	71.9	111.5	72.4	112.4	73.0	57
34	106.1	71.6	106.9	72.1	107.8	72.7	108.6	73.3	109.4	73.8	110.3	74.4	111.1	74.9	56
35	104.9	73.4	105.7	74.0	106.5	74.6	107.3	75.1	108.1	75.7	108.9	76.3	109.8	76.9	55
36	103.6	75.2	104.4	75.8	105.2	76.4	106.0	77.0	106.8	77.6	107.6	78.2	108.4	78.8	54
37	102.2	77.0	103.0	77.6	103.8	78.2	104.6	78.8	105.4	79.4	106.2	80.0	107.0	80.6	53
38	100.9	78.8	101.7	79.4	102.4	80.0	103.2	80.7	104.0	81.3	104.8	81.9	105.6	82.5	52
39	99.5	80.6	100.3	81.2	101.0	81.8	101.8	82.4	102.6	83.1	103.4	83.7	104.1	84.3	51
40	98.1	82.3	98.8	82.9	99.6	83.6	100.4	84.2	101.1	84.8	101.9	85.5	102.6	86.1	50
41	96.6	84.0	97.4	84.6	98.1	85.3	98.9	85.9	99.6	86.6	100.4	87.3	101.1	87.9	49
42	95.1	85.6	95.9	86.3	96.6	87.0	97.4	87.7	98.1	88.3	98.8	89.0	99.6	89.7	48
43	93.6	87.3	94.3	88.0	95.1	88.7	95.8	89.3	96.5	90.0	97.3	90.7	98.0	91.4	47
44	92.1	88.9	92.8	89.6	93.5	90.3	94.2	91.0	95.0	91.7	95.7	92.4	96.4	93.1	46
45	90.5	90.5	91.2	91.2	91.9	91.9	92.6	92.6	93.3	93.3	94.0	94.0	94.8	94.8	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	$D=128'$		$D=129'$		$D=130'$		$D=131'$		$D=132'$		$D=133'$		$D=134'$		

Plane Traverse Table

Course.	D=135′		D=136′		D=137′		D=138′		D=139′		D=140′		D=141′		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	135.0	0.0	136.0	0.0	137.0	0.0	138.0	0.0	139.0	0.0	140.0	0.0	141.0	0.0	90
1	135.0	2.4	136.0	2.4	137.0	2.4	138.0	2.4	139.0	2.4	140.0	2.4	141.0	2.5	89
2	134.9	4.7	135.9	4.7	136.9	4.8	137.9	4.8	138.9	4.9	139.9	4.9	140.9	4.9	88
3	134.8	7.1	135.8	7.1	136.8	7.2	137.8	7.2	138.8	7.3	139.8	7.3	140.8	7.4	87
4	134.7	9.4	135.7	9.5	136.7	9.6	137.7	9.6	138.7	9.7	139.7	9.8	140.7	9.8	86
5	134.5	11.8	135.5	11.9	136.5	11.9	137.5	12.0	138.5	12.1	139.5	12.2	140.5	12.3	85
6	134.3	14.1	135.3	14.2	136.2	14.3	137.2	14.4	138.2	14.5	139.2	14.6	140.2	14.7	84
7	134.0	16.5	135.0	16.6	136.0	16.7	137.0	16.8	138.0	16.9	139.0	17.1	139.9	17.2	83
8	133.7	18.8	134.7	18.9	135.7	19.1	136.7	19.2	137.7	19.3	138.6	19.5	139.6	19.6	82
9	133.3	21.1	134.3	21.3	135.3	21.4	136.3	21.6	137.3	21.7	138.3	21.9	139.3	22.1	81
10	132.9	23.4	133.9	23.6	134.9	23.8	135.9	24.0	136.9	24.1	137.9	24.3	138.9	24.5	80
11	132.5	25.8	133.5	26.0	134.5	26.1	135.5	26.3	136.4	26.5	137.4	26.7	138.4	26.9	79
12	132.0	28.1	133.0	28.3	134.0	28.5	135.0	28.7	136.0	28.9	136.9	29.1	137.9	29.3	78
13	131.5	30.4	132.5	30.6	133.5	30.8	134.5	31.0	135.4	31.3	136.4	31.5	137.4	31.7	77
14	131.0	32.7	132.0	32.9	132.9	33.1	133.9	33.4	134.9	33.6	135.8	33.9	136.8	34.1	76
15	130.4	34.9	131.4	35.2	132.3	35.5	133.3	35.7	134.3	36.0	135.2	36.2	136.2	36.5	75
16	129.8	37.2	130.7	37.5	131.7	37.8	132.7	38.0	133.6	38.3	134.6	38.6	135.5	38.9	74
17	129.1	39.5	130.1	39.8	131.0	40.1	132.0	40.3	132.9	40.6	133.9	40.9	134.8	41.2	73
18	128.4	41.7	129.3	42.0	130.3	42.3	131.2	42.6	132.2	43.0	133.1	43.3	134.1	43.6	72
19	127.6	44.0	128.6	44.3	129.5	44.6	130.5	44.9	131.4	45.3	132.4	45.6	133.3	45.9	71
20	126.9	46.2	127.8	46.5	128.7	46.9	129.7	47.2	130.6	47.5	131.6	47.9	132.5	48.2	70
21	126.0	48.4	127.0	48.7	127.9	49.1	128.8	49.5	129.8	49.8	130.7	50.2	131.6	50.5	69
22	125.2	50.6	126.1	50.9	127.0	51.3	128.0	51.7	128.9	52.1	129.8	52.4	130.7	52.8	68
23	124.3	52.7	125.2	53.1	126.1	53.5	127.0	53.9	128.0	54.3	128.9	54.7	129.8	55.1	67
24	123.3	54.9	124.2	55.3	125.2	55.7	126.1	56.1	127.0	56.5	127.9	56.9	128.8	57.3	66
25	122.4	57.1	123.3	57.5	124.2	57.9	125.1	58.3	126.0	58.7	126.9	59.2	127.8	59.6	65
26	121.3	59.2	122.2	59.6	123.1	60.1	124.0	60.5	124.9	60.9	125.8	61.4	126.7	61.8	64
27	120.3	61.3	121.2	61.7	122.1	62.2	123.0	62.7	123.8	63.1	124.7	63.6	125.6	64.0	63
28	119.2	63.4	120.1	63.8	121.0	64.3	121.8	64.8	122.7	65.3	123.6	65.7	124.5	66.2	62
29	118.1	65.4	118.9	65.9	119.8	66.4	120.7	66.9	121.6	67.4	122.4	67.9	123.3	68.4	61
30	116.9	67.5	117.8	68.0	118.6	68.5	119.5	69.0	120.4	69.5	121.2	70.0	122.1	70.5	60
31	115.7	69.5	116.6	70.0	117.4	70.6	118.3	71.1	119.1	71.6	120.0	72.1	120.9	72.6	59
32	114.5	71.5	115.3	72.1	116.2	72.6	117.0	73.1	117.9	73.7	118.7	74.2	119.6	74.7	58
33	113.2	73.5	114.1	74.1	114.9	74.6	115.7	75.2	116.6	75.7	117.4	76.2	118.3	76.8	57
34	111.9	75.5	112.7	76.1	113.6	76.6	114.4	77.2	115.2	77.7	116.1	78.3	116.9	78.8	56
35	110.6	77.4	111.4	78.0	112.2	78.6	113.0	79.2	113.9	79.7	114.7	80.3	115.5	80.9	55
36	109.2	79.4	110.0	79.9	110.8	80.5	111.6	81.1	112.5	81.7	113.3	82.3	114.1	82.9	54
37	107.8	81.2	108.6	81.8	109.4	82.4	110.2	83.1	111.0	83.7	111.8	84.3	112.6	84.9	53
38	106.4	83.1	107.2	83.7	108.0	84.3	108.7	85.0	109.5	85.6	110.3	86.2	111.1	86.8	52
39	104.9	85.0	105.7	85.6	106.5	86.2	107.2	86.8	108.0	87.5	108.8	88.1	109.6	88.7	51
40	103.4	86.8	104.2	87.4	104.9	88.1	105.7	88.7	106.5	89.3	107.2	90.0	108.0	90.6	50
41	101.9	88.6	102.6	89.2	103.4	89.9	104.1	90.5	104.9	91.2	105.7	91.8	106.4	92.5	49
42	100.3	90.3	101.1	91.0	101.8	91.7	102.6	92.3	103.3	93.0	104.0	93.7	104.8	94.3	48
43	98.7	92.1	99.5	92.8	100.2	93.4	100.9	94.1	101.7	94.8	102.4	95.5	103.1	96.2	47
44	97.1	93.8	97.8	94.5	98.5	95.2	99.3	95.9	100.0	96.6	100.7	97.3	101.4	97.9	46
45	95.5	95.5	96.2	96.2	96.9	96.9	97.6	97.6	98.3	98.3	99.0	99.0	99.7	99.7	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	D=135′		D=136′		D=137′		D=138′		D=139′		D=140′		D=141′		

Plane Traverse Table

Course.	$D=142'$		$D=143'$		$D=144'$		$D=145'$		$D=146'$		$D=147'$		$D=148'$		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	142.0	0.0	143.0	0.0	144.0	0.0	145.0	0.0	146.0	0.0	147.0	0.0	148.0	0.0	90
1	142.0	2.5	143.0	2.5	144.0	2.5	145.0	2.5	146.0	2.5	147.0	2.6	148.0	2.6	89
2	141.9	5.0	142.9	5.0	143.9	5.0	144.9	5.1	145.9	5.1	146.9	5.1	147.9	5.2	88
3	141.8	7.4	142.8	7.5	143.8	7.5	144.8	7.6	145.8	7.6	146.8	7.7	147.8	7.7	87
4	141.7	9.9	142.7	10.0	143.6	10.0	144.6	10.1	145.6	10.2	146.6	10.3	147.6	10.3	86
5	141.5	12.4	142.5	12.5	143.5	12.6	144.4	12.6	145.4	12.7	146.4	12.8	147.4	12.9	85
6	141.2	14.8	142.2	14.9	143.2	15.1	144.2	15.2	145.2	15.3	146.2	15.4	147.2	15.5	84
7	140.9	17.3	141.9	17.4	142.9	17.5	143.9	17.7	144.9	17.8	145.9	17.9	146.9	18.0	83
8	140.6	19.8	141.6	19.9	142.6	20.0	143.6	20.2	144.6	20.3	145.6	20.5	146.6	20.6	82
9	140.3	22.2	141.2	22.4	142.2	22.5	143.2	22.7	144.2	22.8	145.2	23.0	146.2	23.2	81
10	139.8	24.7	140.8	24.8	141.8	25.0	142.8	25.2	143.8	25.4	144.8	25.5	145.8	25.7	80
11	139.4	27.1	140.4	27.3	141.4	27.5	142.3	27.7	143.3	27.9	144.3	28.0	145.3	28.2	79
12	138.9	29.5	139.9	29.7	140.9	29.9	141.8	30.1	142.8	30.4	143.8	30.6	144.8	30.8	78
13	138.4	31.9	139.3	32.2	140.3	32.4	141.3	32.6	142.3	32.8	143.2	33.1	144.2	33.3	77
14	137.8	34.4	138.8	34.6	139.7	34.8	140.7	35.1	141.7	35.3	142.6	35.6	143.6	35.8	76
15	137.2	36.8	138.1	37.0	139.1	37.3	140.1	37.5	141.0	37.8	142.0	38.0	143.0	38.3	75
16	136.5	39.1	137.5	39.4	138.4	39.7	139.4	40.0	140.3	40.2	141.3	40.5	142.3	40.8	74
17	135.8	41.5	136.8	41.8	137.7	42.1	138.7	42.4	139.6	42.7	140.6	43.0	141.5	43.3	73
18	135.1	43.9	136.0	44.2	137.0	44.5	137.9	44.8	138.9	45.1	139.8	45.4	140.8	45.7	72
19	134.3	46.2	135.2	46.6	136.2	46.9	137.1	47.2	138.0	47.5	139.0	47.9	139.9	48.2	71
20	133.4	48.6	134.4	48.9	135.3	49.3	136.3	49.6	137.2	49.9	138.1	50.3	139.1	50.6	70
21	132.6	50.9	133.5	51.2	134.4	51.6	135.4	52.0	136.3	52.3	137.2	52.7	138.2	53.0	69
22	131.7	53.2	132.6	53.6	133.5	53.9	134.4	54.3	135.4	54.7	136.3	55.1	137.2	55.4	68
23	130.7	55.5	131.6	55.9	132.6	56.3	133.5	56.7	134.4	57.0	135.3	57.4	136.2	57.8	67
24	129.7	57.8	130.6	58.2	131.6	58.6	132.5	59.0	133.4	59.4	134.3	59.8	135.2	60.2	66
25	128.7	60.0	129.6	60.4	130.5	60.9	131.4	61.3	132.3	61.7	133.2	62.1	134.1	62.5	65
26	127.6	62.2	128.5	62.7	129.4	63.1	130.3	63.6	131.2	64.0	132.1	64.4	133.0	64.9	64
27	126.5	64.5	127.4	64.9	128.3	65.4	129.2	65.8	130.1	66.3	131.0	66.7	131.9	67.2	63
28	125.4	66.7	126.3	67.1	127.1	67.6	128.0	68.1	128.9	68.5	129.8	69.0	130.7	69.5	62
29	124.2	68.8	125.1	69.3	125.9	69.8	126.8	70.3	127.7	70.8	128.6	71.3	129.4	71.8	61
30	123.0	71.0	123.8	71.5	124.7	72.0	125.6	72.5	126.4	73.0	127.3	73.5	128.2	74.0	60
31	121.7	73.1	122.6	73.7	123.4	74.2	124.3	74.7	125.1	75.2	126.0	75.7	126.9	76.2	59
32	120.4	75.2	121.3	75.8	122.1	76.3	123.0	76.8	123.8	77.4	124.7	77.9	125.5	78.4	58
33	119.1	77.3	119.9	77.9	120.8	78.4	121.6	79.0	122.4	79.5	123.3	80.1	124.1	80.6	57
34	117.7	79.4	118.6	80.0	119.4	80.5	120.2	81.1	121.0	81.6	121.9	82.2	122.7	82.8	56
35	116.3	81.4	117.1	82.0	118.0	82.6	118.8	83.2	119.6	83.7	120.4	84.3	121.2	84.9	55
36	114.9	83.5	115.7	84.1	116.5	84.6	117.3	85.2	118.1	85.8	118.9	86.4	119.7	87.0	54
37	113.4	85.5	114.2	86.1	115.0	86.7	115.8	87.3	116.6	87.9	117.4	88.5	118.2	89.1	53
38	111.9	87.4	112.7	88.0	113.5	88.7	114.3	89.3	115.0	89.9	115.8	90.5	116.6	91.1	52
39	110.4	89.4	111.1	90.0	111.9	90.6	112.7	91.3	113.5	91.9	114.2	92.5	115.0	93.1	51
40	108.8	91.3	109.5	91.9	110.3	92.6	111.1	93.2	111.8	93.8	112.6	94.5	113.4	95.1	50
41	107.2	93.2	107.9	93.8	108.7	94.5	109.4	95.1	110.2	95.8	110.9	96.4	111.7	97.1	49
42	105.5	95.0	106.3	95.7	107.0	96.4	107.8	97.0	108.5	97.7	109.2	98.4	110.0	99.0	48
43	103.9	96.8	104.6	97.5	105.3	98.2	106.0	98.9	106.8	99.6	107.5	100.3	108.2	100.9	47
44	102.1	98.6	102.9	99.3	103.6	100.0	104.3	100.7	105.0	101.4	105.7	102.1	106.5	102.8	46
45	100.4	100.4	101.1	101.1	101.8	101.8	102.5	102.5	103.2	103.2	103.9	103.9	104.7	104.7	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	$D=142'$		$D=143'$		$D=144'$		$D=145'$		$D=146'$		$D=147'$		$D=148'$		

Plane Traverse Table

Course.	$D=149'$		$D=150'$		$D=151'$		$D=152'$		$D=153'$		$D=154'$		$D=155'$		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	149.0	0.0	150.0	0.0	151.0	0.0	152.0	0.0	153.0	0.0	154.0	0.0	155.0	0.0	90
1	149.0	2.6	150.0	2.6	151.0	2.6	152.0	2.7	153.0	2.7	154.0	2.7	155.0	2.7	89
2	148.9	5.2	149.9	5.2	150.9	5.3	151.9	5.3	152.9	5.3	153.9	5.4	154.9	5.4	88
3	148.8	7.8	149.8	7.9	150.8	7.9	151.8	8.0	152.8	8.0	153.8	8.1	154.8	8.1	87
4	148.6	10.4	149.6	10.5	150.6	10.5	151.6	10.6	152.6	10.7	153.6	10.7	154.6	10.8	86
5	148.4	13.0	149.4	13.1	150.4	13.2	151.4	13.2	152.4	13.3	153.4	13.4	154.4	13.5	85
6	148.2	15.6	149.2	15.7	150.2	15.8	151.2	15.9	152.2	16.0	153.2	16.1	154.2	16.2	84
7	147.9	18.2	148.9	18.3	149.9	18.4	150.9	18.5	151.9	18.6	152.9	18.8	153.8	18.9	83
8	147.5	20.7	148.5	20.9	149.5	21.0	150.5	21.2	151.5	21.3	152.5	21.4	153.5	21.6	82
9	147.2	23.3	148.2	23.5	149.1	23.6	150.1	23.8	151.1	23.9	152.1	24.1	153.1	24.2	81
10	146.7	25.9	147.7	26.0	148.7	26.2	149.7	26.4	150.7	26.6	151.7	26.7	152.6	26.9	80
11	146.3	28.4	147.2	28.6	148.2	28.8	149.2	29.0	150.2	29.2	151.2	29.4	152.2	29.6	79
12	145.7	31.0	146.7	31.2	147.7	31.4	148.7	31.6	149.7	31.8	150.6	32.0	151.6	32.2	78
13	145.2	33.5	146.2	33.7	147.1	34.0	148.1	34.2	149.1	34.4	150.1	34.6	151.0	34.9	77
14	144.6	36.0	145.5	36.3	146.5	36.5	147.5	36.8	148.5	37.0	149.4	37.3	150.4	37.5	76
15	143.9	38.6	144.9	38.8	145.9	39.1	146.8	39.3	147.8	39.6	148.8	39.9	149.7	40.1	75
16	143.2	41.1	144.2	41.3	145.2	41.6	146.1	41.9	147.1	42.2	148.0	42.4	149.0	42.7	74
17	142.5	43.6	143.4	43.9	144.4	44.1	145.4	44.4	146.3	44.7	147.3	45.0	148.2	45.3	73
18	141.7	46.0	142.7	46.4	143.6	46.7	144.6	47.0	145.5	47.3	146.5	47.6	147.4	47.9	72
19	140.9	48.5	141.8	48.8	142.8	49.2	143.7	49.5	144.7	49.8	145.6	50.1	146.6	50.5	71
20	140.0	51.0	141.0	51.3	141.9	51.6	142.8	52.0	143.8	52.3	144.7	52.7	145.7	53.0	70
21	139.1	53.4	140.0	53.8	141.0	54.1	141.9	54.5	142.8	54.8	143.8	55.2	144.7	55.5	69
22	138.2	55.8	139.1	56.2	140.0	56.6	140.9	56.9	141.9	57.3	142.8	57.7	143.7	58.1	68
23	137.2	58.2	138.1	58.6	139.0	59.0	139.9	59.4	140.8	59.8	141.8	60.2	142.7	60.6	67
24	136.1	60.6	137.0	61.0	137.9	61.4	138.9	61.8	139.8	62.2	140.7	62.6	141.6	63.0	66
25	135.0	63.0	135.9	63.4	136.9	63.8	137.8	64.2	138.7	64.7	139.6	65.1	140.5	65.5	65
26	133.9	65.3	134.8	65.8	135.7	66.2	136.6	66.6	137.5	67.1	138.4	67.5	139.3	67.9	64
27	132.8	67.6	133.7	68.1	134.5	68.6	135.4	69.0	136.3	69.5	137.2	69.9	138.1	70.4	63
28	131.6	70.0	132.4	70.4	133.3	70.9	134.2	71.4	135.1	71.8	136.0	72.3	136.9	72.8	62
29	130.3	72.2	131.2	72.7	132.1	73.2	132.9	73.7	133.8	74.2	134.7	74.7	135.6	75.1	61
30	129.0	74.5	129.9	75.0	130.8	75.5	131.6	76.0	132.5	76.5	133.4	77.0	134.2	77.5	60
31	127.7	76.7	128.6	77.3	129.4	77.8	130.3	78.3	131.1	78.8	132.0	79.3	132.9	79.8	59
32	126.4	79.0	127.2	79.5	128.1	80.0	128.9	80.5	129.8	81.1	130.6	81.6	131.4	82.1	58
33	125.0	81.2	125.8	81.7	126.6	82.2	127.5	82.8	128.3	83.3	129.2	83.9	130.0	84.4	57
34	123.5	83.3	124.4	83.9	125.2	84.4	126.0	85.0	126.8	85.6	127.7	86.1	128.5	86.7	56
35	122.1	85.5	122.9	86.0	123.7	86.6	124.5	87.2	125.3	87.8	126.1	88.3	127.0	88.9	55
36	120.5	87.6	121.4	88.2	122.2	88.8	123.0	89.3	123.8	89.9	124.6	90.5	125.4	91.1	54
37	119.0	89.7	119.8	90.3	120.6	90.9	121.4	91.5	122.2	92.1	123.0	92.7	123.8	93.3	53
38	117.4	91.7	118.2	92.3	119.0	93.0	119.8	93.6	120.6	94.2	121.4	94.8	122.1	95.4	52
39	115.8	93.8	116.6	94.4	117.3	95.0	118.1	95.7	118.9	96.3	119.7	96.9	120.5	97.5	51
40	114.1	95.8	114.9	96.4	115.7	97.1	116.4	97.7	117.2	98.3	118.0	99.0	118.7	99.6	50
41	112.5	97.8	113.2	98.4	114.0	99.1	114.7	99.7	115.5	100.4	116.2	101.0	117.0	101.7	49
42	110.7	99.7	111.5	100.4	112.2	101.0	113.0	101.7	113.7	102.4	114.4	103.0	115.2	103.7	48
43	109.0	101.6	109.7	102.3	110.4	103.0	111.2	103.7	111.9	104.3	112.6	105.0	113.4	105.7	47
44	107.2	103.5	107.9	104.2	108.6	104.9	109.3	105.6	110.1	106.3	110.8	107.0	111.5	107.7	46
45	105.4	105.4	106.1	106.1	106.8	106.8	107.5	107.5	108.2	108.2	108.9	108.9	109.6	109.6	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	$D=149'$		$D=150'$		$D=151'$		$D=152'$		$D=153'$		$D=154'$		$D=155'$		

Plane Traverse Table

Course.	$D=156'$		$D=157'$		$D=158'$		$D=159'$		$D=160'$		$D=161'$		$D=162'$		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	156.0	0.0	157.0	0.0	158.0	0.0	159.0	0.0	160.0	0.0	161.0	0.0	162.0	0.0	90
1	156.0	2.7	157.0	2.7	158.0	2.8	159.0	2.8	160.0	2.8	161.0	2.8	162.0	2.8	89
2	155.9	5.4	156.9	5.5	157.9	5.5	158.9	5.5	159.9	5.6	160.9	5.6	161.9	5.7	88
3	155.8	8.2	156.8	8.2	157.8	8.3	158.8	8.3	159.8	8.4	160.8	8.4	161.8	8.5	87
4	155.6	10.9	156.6	11.0	157.6	11.0	158.6	11.1	159.6	11.2	160.6	11.2	161.6	11.3	86
5	155.4	13.6	156.4	13.7	157.4	13.8	158.4	13.9	159.4	13.9	160.4	14.0	161.4	14.1	85
6	155.1	16.3	156.1	16.4	157.1	16.5	158.1	16.6	159.1	16.7	160.1	16.8	161.1	16.9	84
7	154.8	19.0	155.8	19.1	156.8	19.3	157.8	19.4	158.8	19.5	159.8	19.6	160.8	19.7	83
8	154.5	21.7	155.5	21.9	156.5	22.0	157.5	22.1	158.4	22.3	159.4	22.4	160.4	22.5	82
9	154.1	24.4	155.1	24.6	156.1	24.7	157.0	24.9	158.0	25.0	159.0	25.2	160.0	25.3	81
10	153.6	27.1	154.6	27.3	155.6	27.4	156.6	27.6	157.6	27.8	158.6	28.0	159.5	28.1	80
11	153.1	29.8	154.1	30.0	155.1	30.1	156.1	30.3	157.1	30.5	158.0	30.7	159.0	30.9	79
12	152.6	32.4	153.6	32.6	154.5	32.9	155.5	33.1	156.5	33.3	157.5	33.5	158.5	33.7	78
13	152.0	35.1	153.0	35.3	154.0	35.5	154.9	35.8	155.9	36.0	156.9	36.2	157.8	36.4	77
14	151.4	37.7	152.3	38.0	153.3	38.2	154.3	38.5	155.2	38.7	156.2	38.9	157.2	39.2	76
15	150.7	40.4	151.7	40.6	152.6	40.9	153.6	41.2	154.5	41.4	155.5	41.7	156.5	41.9	75
16	150.0	43.0	150.9	43.3	151.9	43.6	152.8	43.8	153.8	44.1	154.8	44.4	155.7	44.7	74
17	149.2	45.6	150.1	45.9	151.1	46.2	152.1	46.5	153.0	46.8	154.0	47.1	154.9	47.4	73
18	148.4	48.2	149.3	48.5	150.3	48.8	151.2	49.1	152.2	49.4	153.1	49.8	154.1	50.1	72
19	147.5	50.8	148.4	51.1	149.4	51.4	150.3	51.8	151.3	52.1	152.2	52.4	153.2	52.7	71
20	146.6	53.4	147.5	53.7	148.5	54.0	149.4	54.4	150.4	54.7	151.3	55.1	152.2	55.4	70
21	145.6	55.9	146.6	56.3	147.5	56.6	148.4	57.0	149.4	57.3	150.3	57.7	151.2	58.1	69
22	144.6	58.4	145.6	58.8	146.5	59.2	147.4	59.6	148.3	59.9	149.3	60.3	150.2	60.7	68
23	143.6	61.0	144.5	61.3	145.4	61.7	146.4	62.1	147.3	62.5	148.2	62.9	149.1	63.3	67
24	142.5	63.5	143.4	63.9	144.3	64.3	145.3	64.7	146.2	65.1	147.1	65.5	148.0	65.9	66
25	141.4	65.9	142.3	66.4	143.2	66.8	144.1	67.2	145.0	67.6	145.9	68.0	146.8	68.5	65
26	140.2	68.4	141.1	68.8	142.0	69.3	142.9	69.7	143.8	70.1	144.7	70.6	145.6	71.0	64
27	139.0	70.8	139.9	71.3	140.8	71.7	141.7	72.2	142.6	72.6	143.5	73.1	144.3	73.5	63
28	137.7	73.2	138.6	73.7	139.5	74.2	140.4	74.6	141.3	75.1	142.2	75.6	143.0	76.1	62
29	136.4	75.6	137.3	76.1	138.2	76.6	139.1	77.1	139.9	77.6	140.8	78.1	141.7	78.5	61
30	135.1	78.0	136.0	78.5	136.8	79.0	137.7	79.5	138.6	80.0	139.4	80.5	140.3	81.0	60
31	133.7	80.3	134.6	80.9	135.4	81.4	136.3	81.9	137.1	82.4	138.0	82.9	138.9	83.4	59
32	132.3	82.7	133.1	83.2	134.0	83.7	134.8	84.3	135.7	84.8	136.5	85.3	137.4	85.8	58
33	130.8	85.0	131.7	85.5	132.5	86.1	133.3	86.6	134.2	87.1	135.0	87.7	135.9	88.2	57
34	129.3	87.2	130.2	87.8	131.0	88.4	131.8	88.9	132.6	89.5	133.5	90.0	134.3	90.6	56
35	127.8	89.5	128.6	90.1	129.4	90.6	130.2	91.2	131.1	91.8	131.9	92.3	132.7	92.9	55
36	126.2	91.7	127.0	92.3	127.8	92.9	128.6	93.5	129.4	94.0	130.3	94.6	131.1	95.2	54
37	124.6	93.9	125.4	94.5	126.2	95.1	127.0	95.7	127.8	96.3	128.6	96.9	129.4	97.5	53
38	122.9	96.0	123.7	96.7	124.5	97.3	125.3	97.9	126.1	98.5	126.9	99.1	127.7	99.7	52
39	121.2	98.2	122.0	98.8	122.8	99.4	123.6	100.1	124.3	100.7	125.1	101.3	125.9	101.9	51
40	119.5	100.3	120.3	100.9	121.0	101.6	121.8	102.2	122.6	102.8	123.3	103.5	124.1	104.1	50
41	117.7	102.3	118.5	103.0	119.2	103.7	120.0	104.3	120.8	105.0	121.5	105.6	122.3	106.3	49
42	115.9	104.4	116.7	105.1	117.4	105.7	118.2	106.4	118.9	107.1	119.6	107.7	120.4	108.4	48
43	114.1	106.4	114.8	107.1	115.6	107.8	116.3	108.4	117.0	109.1	117.7	109.8	118.5	110.5	47
44	112.2	108.4	112.9	109.1	113.7	109.8	114.4	110.5	115.1	111.1	115.8	111.8	116.5	112.5	46
45	110.3	110.3	111.0	111.0	111.7	111.7	112.4	112.4	113.1	113.1	113.8	113.8	114.6	114.6	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	$D=156'$		$D=157'$		$D=158'$		$D=159'$		$D=160'$		$D=161'$		$D=162'$		

Plane Traverse Table

Course.	$D=163'$		$D=164'$		$D=165'$		$D=166'$		$D=167'$		$D=168'$		$D=169'$		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	163.0	0.0	164.0	0.0	165.0	0.0	166.0	0.0	167.0	0.0	168.0	0.0	169.0	0.0	90
1	163.0	2.8	164.0	2.9	165.0	2.9	166.0	2.9	167.0	2.9	168.0	2.9	169.0	2.9	89
2	162.9	5.7	163.9	5.7	164.9	5.8	165.9	5.8	166.9	5.8	167.9	5.9	168.9	5.9	88
3	162.8	8.5	163.8	8.6	164.8	8.6	165.8	8.7	166.8	8.7	167.8	8.8	168.8	8.8	87
4	162.6	11.4	163.6	11.4	164.6	11.5	165.6	11.6	166.6	11.6	167.6	11.7	168.6	11.8	86
5	162.4	14.2	163.4	14.3	164.4	14.4	165.4	14.5	166.4	14.6	167.4	14.6	168.4	14.7	85
6	162.1	17.0	163.1	17.1	164.1	17.2	165.1	17.4	166.1	17.5	167.1	17.6	168.1	17.7	84
7	161.8	19.9	162.8	20.0	163.8	20.1	164.8	20.2	165.8	20.4	166.7	20.5	167.7	20.6	83
8	161.4	22.7	162.4	22.8	163.4	23.0	164.4	23.1	165.4	23.2	166.4	23.4	167.4	23.5	82
9	161.0	25.5	162.0	25.7	163.0	25.8	164.0	26.0	164.9	26.1	165.9	26.3	166.9	26.4	81
10	160.5	28.3	161.5	28.5	162.5	28.7	163.5	28.8	164.5	29.0	165.4	29.2	166.4	29.3	80
11	160.0	31.1	161.0	31.3	162.0	31.5	163.0	31.7	163.9	31.9	164.9	32.1	165.9	32.2	79
12	159.4	33.9	160.4	34.1	161.4	34.3	162.4	34.5	163.4	34.7	164.3	34.9	165.3	35.1	78
13	158.8	36.7	159.8	36.9	160.8	37.1	161.7	37.3	162.7	37.6	163.7	37.8	164.7	38.0	77
14	158.2	39.4	159.1	39.7	160.1	39.9	161.1	40.2	162.0	40.4	163.0	40.6	164.0	40.9	76
15	157.4	42.2	158.4	42.4	159.4	42.7	160.3	43.0	161.3	43.2	162.3	43.5	163.2	43.7	75
16	156.7	44.9	157.6	45.2	158.6	45.5	159.6	45.8	160.5	46.0	161.5	46.3	162.5	46.6	74
17	155.9	47.7	156.8	47.9	157.8	48.2	158.7	48.5	159.7	48.8	160.7	49.1	161.6	49.4	73
18	155.0	50.4	156.0	50.7	156.9	51.0	157.9	51.3	158.8	51.6	159.8	51.9	160.7	52.2	72
19	154.1	53.1	155.1	53.4	156.0	53.7	157.0	54.0	157.9	54.4	158.8	54.7	159.8	55.0	71
20	153.2	55.7	154.1	56.1	155.0	56.4	156.0	56.8	156.9	57.1	157.9	57.5	158.8	57.8	70
21	152.2	58.4	153.1	58.8	154.0	59.1	155.0	59.5	155.9	59.8	156.8	60.2	157.8	60.6	69
22	151.1	61.1	152.1	61.4	153.0	61.8	153.9	62.2	154.8	62.6	155.8	62.9	156.7	63.3	68
23	150.0	63.7	151.0	64.1	151.9	64.5	152.8	64.9	153.7	65.3	154.6	65.6	155.6	66.0	67
24	148.9	66.3	149.8	66.7	150.7	67.1	151.6	67.5	152.6	67.9	153.5	68.3	154.4	68.7	66
25	147.7	68.9	148.6	69.3	149.5	69.7	150.4	70.2	151.4	70.6	152.3	71.0	153.2	71.4	65
26	146.5	71.5	147.4	71.9	148.3	72.3	149.2	72.8	150.1	73.2	151.0	73.6	151.9	74.1	64
27	145.2	74.0	146.1	74.5	147.0	74.9	147.9	75.4	148.8	75.8	149.7	76.3	150.6	76.7	63
28	143.9	76.5	144.8	77.0	145.7	77.5	146.6	77.9	147.5	78.4	148.3	78.9	149.2	79.3	62
29	142.6	79.0	143.4	79.5	144.3	80.0	145.2	80.5	146.1	81.0	146.9	81.4	147.8	81.9	61
30	141.2	81.5	142.0	82.0	142.9	82.5	143.8	83.0	144.6	83.5	145.5	84.0	146.4	84.5	60
31	139.7	84.0	140.6	84.5	141.4	85.0	142.3	85.5	143.1	86.0	144.0	86.5	144.9	87.0	59
32	138.2	86.4	139.1	86.9	139.9	87.4	140.8	88.0	141.6	88.5	142.5	89.0	143.3	89.6	58
33	136.7	88.8	137.5	89.3	138.4	89.9	139.2	90.4	140.1	91.0	140.9	91.5	141.7	92.0	57
34	135.1	91.1	136.0	91.7	136.8	92.3	137.6	92.8	138.4	93.4	139.3	93.9	140.1	94.5	56
35	133.5	93.5	134.3	94.1	135.2	94.6	136.0	95.2	136.8	95.8	137.6	96.4	138.4	96.9	55
36	131.9	95.8	132.7	96.4	133.5	97.0	134.3	97.6	135.1	98.2	135.9	98.7	136.7	99.3	54
37	130.2	98.1	131.0	98.7	131.8	99.3	132.6	99.9	133.4	100.5	134.2	101.1	135.0	101.7	53
38	128.4	100.4	129.2	101.0	130.0	101.6	130.8	102.2	131.6	102.8	132.4	103.4	133.2	104.0	52
39	126.7	102.6	127.5	103.2	128.2	103.8	129.0	104.5	129.8	105.1	130.6	105.7	131.3	106.4	51
40	124.9	104.8	125.6	105.4	126.4	106.1	127.2	106.7	127.9	107.3	128.7	108.0	129.5	108.6	50
41	123.0	106.9	123.8	107.6	124.5	108.2	125.3	108.9	126.0	109.6	126.8	110.2	127.5	110.9	49
42	121.1	109.1	121.9	109.7	122.6	110.4	123.4	111.1	124.1	111.7	124.8	112.4	125.6	113.1	48
43	119.2	111.2	119.9	111.8	120.7	112.5	121.4	113.2	122.1	113.9	122.9	114.6	123.6	115.3	47
44	117.3	113.2	118.0	113.9	118.7	114.6	119.4	115.3	120.1	116.0	120.8	116.7	121.6	117.4	46
45	115.3	115.3	116.0	116.0	116.7	116.7	117.4	117.4	118.1	118.1	118.8	118.8	119.5	119.5	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	$D=163'$		$D=164'$		$D=165'$		$D=166'$		$D=167'$		$D=168'$		$D=169'$		

Plane Traverse Table

Course.	D = 170′		D = 171′		D = 172′		D = 173′		D = 174′		D = 175′		D = 176′		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	170.0	0.0	171.0	0.0	172.0	0.0	173.0	0.0	174.0	0.0	175.0	0.0	176.0	0.0	90
1	170.0	3.0	171.0	3.0	172.0	3.0	173.0	3.0	174.0	3.0	175.0	3.1	176.0	3.1	89
2	169.9	5.9	170.9	6.0	171.9	6.0	172.9	6.0	173.9	6.1	174.9	6.1	175.9	6.1	88
3	169.8	8.9	170.8	8.9	171.8	9.0	172.8	9.1	173.8	9.1	174.8	9.2	175.8	9.2	87
4	169.6	11.9	170.6	11.9	171.6	12.0	172.6	12.1	173.6	12.1	174.6	12.2	175.6	12.3	86
5	169.4	14.8	170.3	14.9	171.3	15.0	172.3	15.1	173.3	15.2	174.3	15.3	175.3	15.3	85
6	169.1	17.8	170.1	17.9	171.1	18.0	172.1	18.1	173.0	18.2	174.0	18.3	175.0	18.4	84
7	168.7	20.7	169.7	20.8	170.7	21.0	171.7	21.1	172.7	21.2	173.7	21.3	174.7	21.4	83
8	168.3	23.7	169.3	23.8	170.3	23.9	171.3	24.1	172.3	24.2	173.3	24.4	174.3	24.5	82
9	167.9	26.6	168.9	26.8	169.9	26.9	170.9	27.1	171.9	27.2	172.8	27.4	173.8	27.5	81
10	167.4	29.5	168.4	29.7	169.4	29.9	170.4	30.0	171.4	30.2	172.3	30.4	173.3	30.6	80
11	166.9	32.4	167.9	32.6	168.8	32.8	169.8	33.0	170.8	33.2	171.8	33.4	172.8	33.6	79
12	166.3	35.3	167.3	35.6	168.2	35.8	169.2	36.0	170.2	36.2	171.2	36.4	172.2	36.6	78
13	165.6	38.2	166.6	38.5	167.6	38.7	168.6	38.9	169.5	39.1	170.5	39.4	171.5	39.6	77
14	165.0	41.1	165.9	41.4	166.9	41.6	167.9	41.9	168.8	42.1	169.8	42.3	170.8	42.6	76
15	164.2	44.0	165.2	44.3	166.1	44.5	167.1	44.8	168.1	45.0	169.0	45.3	170.0	45.6	75
16	163.4	46.9	164.4	47.1	165.3	47.4	166.3	47.7	167.3	48.0	168.2	48.2	169.2	48.5	74
17	162.6	49.7	163.5	50.0	164.5	50.3	165.4	50.6	166.4	50.9	167.4	51.2	168.3	51.5	73
18	161.7	52.5	162.6	52.8	163.6	53.2	164.5	53.5	165.5	53.8	166.4	54.1	167.4	54.4	72
19	160.7	55.3	161.7	55.7	162.6	56.0	163.6	56.3	164.5	56.6	165.5	57.0	166.4	57.3	71
20	159.7	58.1	160.7	58.5	161.6	58.8	162.6	59.2	163.5	59.5	164.4	59.9	165.4	60.2	70
21	158.7	60.9	159.6	61.3	160.6	61.6	161.5	62.0	162.4	62.4	163.4	62.7	164.3	63.1	69
22	157.6	63.7	158.5	64.1	159.5	64.4	160.4	64.8	161.3	65.2	162.3	65.6	163.2	65.9	68
23	156.5	66.4	157.4	66.8	158.3	67.2	159.2	67.6	160.2	68.0	161.1	68.4	162.0	68.8	67
24	155.3	69.1	156.2	69.6	157.1	70.0	158.0	70.4	159.0	70.8	159.9	71.2	160.8	71.6	66
25	154.1	71.8	155.0	72.3	155.9	72.7	156.8	73.1	157.7	73.5	158.6	74.0	159.5	74.4	65
26	152.8	74.5	153.7	75.0	154.6	75.4	155.5	75.8	156.4	76.3	157.3	76.7	158.2	77.2	64
27	151.5	77.2	152.4	77.6	153.3	78.1	154.1	78.5	155.0	79.0	155.9	79.4	156.8	79.9	63
28	150.1	79.8	151.0	80.3	151.9	80.7	152.7	81.2	153.6	81.7	154.5	82.2	155.4	82.6	62
29	148.7	82.4	149.6	82.9	150.4	83.4	151.3	83.9	152.2	84.4	153.1	84.8	153.9	85.3	61
30	147.2	85.0	148.1	85.5	149.0	86.0	149.8	86.5	150.7	87.0	151.6	87.5	152.4	88.0	60
31	145.7	87.6	146.6	88.1	147.4	88.6	148.3	89.1	149.1	89.6	150.0	90.1	150.9	90.6	59
32	144.2	90.1	145.0	90.6	145.9	91.1	146.7	91.7	147.6	92.2	148.4	92.7	149.3	93.3	58
33	142.6	92.6	143.4	93.1	144.3	93.7	145.1	94.2	145.9	94.8	146.8	95.3	147.6	95.9	57
34	140.9	95.1	141.8	95.6	142.6	96.2	143.4	96.7	144.3	97.3	145.1	97.9	145.9	98.4	56
35	139.3	97.5	140.1	98.1	140.9	98.7	141.7	99.2	142.5	99.8	143.4	100.4	144.2	100.9	55
36	137.5	99.9	138.3	100.5	139.2	101.1	140.0	101.7	140.8	102.3	141.6	102.9	142.4	103.5	54
37	135.8	102.3	136.6	102.9	137.4	103.5	138.2	104.1	139.0	104.7	139.8	105.3	140.6	105.9	53
38	134.0	104.7	134.7	105.3	135.5	105.9	136.3	106.5	137.1	107.1	137.9	107.7	138.7	108.4	52
39	132.1	107.0	132.9	107.6	133.7	108.2	134.4	108.9	135.2	109.5	136.0	110.1	136.8	110.8	51
40	130.2	109.3	131.0	109.9	131.8	110.6	132.5	111.2	133.3	111.8	134.1	112.5	134.8	113.1	50
41	128.3	111.5	129.1	112.2	129.8	112.8	130.6	113.5	131.3	114.2	132.1	114.8	132.8	115.5	49
42	126.3	113.8	127.1	114.4	127.8	115.1	128.6	115.8	129.3	116.4	130.1	117.1	130.8	117.8	48
43	124.3	115.9	125.1	116.6	125.8	117.3	126.5	118.0	127.3	118.7	128.0	119.3	128.7	120.0	47
44	122.3	118.1	123.0	118.8	123.7	119.5	124.4	120.2	125.2	120.9	125.9	121.6	126.6	122.3	46
45	120.2	120.2	120.9	120.9	121.6	121.6	122.3	122.3	123.0	123.0	123.7	123.7	124.5	124.5	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	D = 170′		D = 171′		D = 172′		D = 173′		D = 174′		D = 175′		D = 176′		

Plane Traverse Table

Course.	D = 177′		D = 178′		D = 179′		D = 180′		D = 181′		D = 182′		D = 183′		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	177.0	0.0	178.0	0.0	179.0	0.0	180.0	0.0	181.0	0.0	182.0	0.0	183.0	0.0	90
1	177.0	3.1	178.0	3.1	179.0	3.1	180.0	3.1	181.0	3.2	182.0	3.2	183.0	3.2	89
2	176.9	6.2	177.9	6.2	178.9	6.2	179.9	6.3	180.9	6.3	181.9	6.4	182.9	6.4	88
3	176.8	9.3	177.8	9.3	178.8	9.4	179.8	9.4	180.8	9.5	181.8	9.5	182.7	9.6	87
4	176.6	12.3	177.6	12.4	178.6	12.5	179.6	12.6	180.6	12.6	181.6	12.7	182.6	12.8	86
5	176.3	15.4	177.3	15.5	178.3	15.6	179.3	15.7	180.3	15.8	181.3	15.9	182.3	15.9	85
6	176.0	18.5	177.0	18.6	178.0	18.7	179.0	18.8	180.0	18.9	181.0	19.0	182.0	19.1	84
7	175.7	21.6	176.7	21.7	177.7	21.8	178.7	21.9	179.7	22.1	180.6	22.2	181.6	22.3	83
8	175.3	24.6	176.3	24.8	177.3	24.9	178.2	25.1	179.2	25.2	180.2	25.3	181.2	25.5	82
9	174.8	27.7	175.8	27.8	176.8	28.0	177.8	28.2	178.8	28.3	179.8	28.5	180.7	28.6	81
10	174.3	30.7	175.3	30.9	176.3	31.1	177.3	31.3	178.3	31.4	179.2	31.6	180.2	31.8	80
11	173.7	33.8	174.7	34.0	175.7	34.2	176.7	34.3	177.7	34.5	178.7	34.7	179.6	34.9	79
12	173.1	36.8	174.1	37.0	175.1	37.2	176.1	37.4	177.0	37.6	178.0	37.8	179.0	38.0	78
13	172.5	39.8	173.4	40.0	174.4	40.3	175.4	40.5	176.4	40.7	177.3	40.9	178.3	41.2	77
14	171.7	42.8	172.7	43.1	173.7	43.3	174.7	43.5	175.6	43.8	176.6	44.0	177.6	44.3	76
15	171.0	45.8	171.9	46.1	172.9	46.3	173.9	46.6	174.8	46.8	175.8	47.1	176.8	47.4	75
16	170.1	48.8	171.1	49.1	172.1	49.3	173.0	49.6	174.0	49.9	174.9	50.2	175.9	50.4	74
17	169.3	51.7	170.2	52.0	171.2	52.3	172.1	52.6	173.1	52.9	174.0	53.2	175.0	53.5	73
18	168.3	54.7	169.3	55.0	170.2	55.3	171.2	55.6	172.1	55.9	173.1	56.2	174.0	56.6	72
19	167.4	57.6	168.3	58.0	169.2	58.3	170.2	58.6	171.1	58.9	172.1	59.3	173.0	59.6	71
20	166.3	60.5	167.3	60.9	168.2	61.2	169.1	61.6	170.1	61.9	171.0	62.2	172.0	62.6	70
21	165.2	63.4	166.2	63.8	167.1	64.1	168.0	64.5	169.0	64.9	169.9	65.2	170.8	65.6	69
22	164.1	66.3	165.0	66.7	166.0	67.1	166.9	67.4	167.8	67.8	168.7	68.2	169.7	68.6	68
23	162.9	69.2	163.8	69.6	164.8	69.9	165.7	70.3	166.6	70.7	167.5	71.1	168.5	71.5	67
24	161.7	72.0	162.6	72.4	163.5	72.8	164.4	73.2	165.4	73.6	166.3	74.0	167.2	74.4	66
25	160.4	74.8	161.3	75.2	162.2	75.6	163.1	76.1	164.0	76.5	164.9	76.9	165.9	77.3	65
26	159.1	77.6	160.0	78.0	160.9	78.5	161.8	78.9	162.7	79.3	163.6	79.8	164.5	80.2	64
27	157.7	80.4	158.6	80.8	159.5	81.3	160.4	81.7	161.3	82.2	162.2	82.6	163.1	83.1	63
28	156.3	83.1	157.2	83.6	158.0	84.0	158.9	84.5	159.8	85.0	160.7	85.4	161.6	85.9	62
29	154.8	85.8	155.7	86.3	156.6	86.8	157.4	87.3	158.3	87.8	159.2	88.2	160.1	88.7	61
30	153.3	88.5	154.2	89.0	155.0	89.5	155.9	90.0	156.8	90.5	157.6	91.0	158.5	91.5	60
31	151.7	91.2	152.6	91.7	153.4	92.2	154.3	92.7	155.1	93.2	156.0	93.7	156.9	94.3	59
32	150.1	93.8	151.0	94.3	151.8	94.9	152.6	95.4	153.5	95.9	154.3	96.4	155.2	97.0	58
33	148.4	96.4	149.3	96.9	150.1	97.5	151.0	98.0	151.8	98.6	152.6	99.1	153.5	99.7	57
34	146.7	99.0	147.6	99.5	148.4	100.1	149.2	100.7	150.1	101.2	150.9	101.8	151.7	102.3	56
35	145.0	101.5	145.8	102.1	146.6	102.7	147.4	103.2	148.3	103.8	149.1	104.4	149.9	105.0	55
36	143.2	104.0	144.0	104.6	144.8	105.2	145.6	105.8	146.4	106.4	147.2	107.0	148.1	107.6	54
37	141.4	106.5	142.2	107.1	143.0	107.7	143.8	108.3	144.6	108.9	145.4	109.5	146.2	110.1	53
38	139.5	109.0	140.3	109.6	141.1	110.2	141.8	110.8	142.6	111.4	143.4	112.1	144.2	112.7	52
39	137.6	111.4	138.3	112.0	139.1	112.6	139.9	113.3	140.7	113.9	141.4	114.5	142.2	115.2	51
40	135.6	113.8	136.4	114.4	137.1	115.1	137.9	115.7	138.7	116.3	139.4	117.0	140.2	117.6	50
41	133.6	116.1	134.3	116.8	135.1	117.4	135.8	118.1	136.6	118.7	137.4	119.4	138.1	120.1	49
42	131.5	118.4	132.3	119.1	133.0	119.8	133.8	120.4	134.5	121.1	135.3	121.8	136.0	122.5	48
43	129.4	120.7	130.2	121.4	130.9	122.1	131.6	122.8	132.4	123.4	133.1	124.1	133.8	124.8	47
44	127.3	123.0	128.0	123.6	128.8	124.3	129.5	125.0	130.2	125.7	130.9	126.4	131.6	127.1	46
45	125.2	125.2	125.9	125.9	126.6	126.6	127.3	127.3	128.0	128.0	128.7	128.7	129.4	129.4	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	D = 177′		D = 178′		D = 179′		D = 180′		D = 181′		D = 182′		D = 183′		

Plane Traverse Table

Course.	D = 184′		D = 185′		D = 186′		D = 187′		D = 188′		D = 189′		D = 190′		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	184.0	0.0	185.0	0.0	186.0	0.0	187.0	0.0	188.0	0.0	189.0	0.0	190.0	0.0	90
1	184.0	3.2	185.0	3.2	186.0	3.2	187.0	3.3	188.0	3.3	189.0	3.3	190.0	3.3	89
2	183.9	6.4	184.9	6.5	185.9	6.5	186.9	6.5	187.9	6.6	188.9	6.6	189.9	6.6	88
3	183.7	9.6	184.7	9.7	185.7	9.7	186.7	9.8	187.7	9.8	188.7	9.9	189.7	9.9	87
4	183.6	12.8	184.5	12.9	185.5	13.0	186.5	13.0	187.5	13.1	188.5	13.2	189.5	13.3	86
5	183.3	16.0	184.3	16.1	185.3	16.2	186.3	16.3	187.3	16.4	188.3	16.5	189.3	16.6	85
6	183.0	19.2	184.0	19.3	185.0	19.4	186.0	19.5	187.0	19.7	188.0	19.8	189.0	19.9	84
7	182.6	22.4	183.6	22.5	184.6	22.7	185.6	22.8	186.6	22.9	187.6	23.0	188.6	23.2	83
8	182.2	25.6	183.2	25.7	184.2	25.9	185.2	26.0	186.2	26.2	187.2	26.3	188.2	26.4	82
9	181.7	28.8	182.7	28.9	183.7	29.1	184.7	29.3	185.7	29.4	186.7	29.6	187.7	29.7	81
10	181.2	32.0	182.2	32.1	183.2	32.3	184.2	32.5	185.1	32.6	186.1	32.8	187.1	33.0	80
11	180.6	35.1	181.6	35.3	182.6	35.5	183.6	35.7	184.5	35.9	185.5	36.1	186.5	36.3	79
12	180.0	38.3	181.0	38.5	181.9	38.7	182.9	38.9	183.9	39.1	184.9	39.3	185.8	39.5	78
13	179.3	41.4	180.3	41.6	181.2	41.8	182.2	42.1	183.2	42.3	184.2	42.5	185.1	42.7	77
14	178.5	44.5	179.5	44.8	180.5	45.0	181.4	45.2	182.4	45.5	183.4	45.7	184.4	46.0	76
15	177.7	47.6	178.7	47.9	179.7	48.1	180.6	48.4	181.6	48.7	182.6	48.9	183.5	49.2	75
16	176.9	50.7	177.8	51.0	178.8	51.3	179.8	51.5	180.7	51.8	181.7	52.1	182.6	52.4	74
17	176.0	53.8	176.9	54.1	177.9	54.4	178.8	54.7	179.8	55.0	180.7	55.3	181.7	55.6	73
18	175.0	56.9	175.9	57.2	176.9	57.5	177.8	57.8	178.8	58.1	179.7	58.4	180.7	58.7	72
19	174.0	59.9	174.9	60.2	175.9	60.6	176.8	60.9	177.8	61.2	178.7	61.5	179.6	61.9	71
20	172.9	62.9	173.8	63.3	174.8	63.6	175.7	64.0	176.7	64.3	177.6	64.6	178.5	65.0	70
21	171.8	65.9	172.7	66.3	173.6	66.7	174.6	67.0	175.5	67.4	176.4	67.7	177.4	68.1	69
22	170.6	68.9	171.5	69.3	172.5	69.7	173.4	70.1	174.3	70.4	175.2	70.8	176.2	71.2	68
23	169.4	71.9	170.3	72.3	171.2	72.7	172.1	73.1	173.1	73.5	174.0	73.8	174.9	74.2	67
24	168.1	74.8	169.0	75.2	169.9	75.7	170.8	76.1	171.7	76.5	172.7	76.9	173.6	77.3	66
25	166.8	77.8	167.7	78.2	168.6	78.6	169.5	79.0	170.4	79.5	171.3	79.9	172.2	80.3	65
26	165.4	80.7	166.3	81.1	167.2	81.5	168.1	82.0	169.0	82.4	169.9	82.9	170.8	83.3	64
27	163.9	83.5	164.8	84.0	165.7	84.4	166.6	84.9	167.5	85.4	168.4	85.8	169.3	86.3	63
28	162.5	86.4	163.3	86.9	164.2	87.3	165.1	87.8	166.0	88.3	166.9	88.7	167.8	89.2	62
29	160.9	89.2	161.8	89.7	162.7	90.2	163.6	90.7	164.4	91.1	165.3	91.6	166.2	92.1	61
30	159.3	92.0	160.2	92.5	161.1	93.0	161.9	93.5	162.8	94.0	163.7	94.5	164.5	95.0	60
31	157.7	94.8	158.6	95.3	159.4	95.8	160.3	96.3	161.1	96.8	162.0	97.3	162.9	97.9	59
32	156.0	97.5	156.9	98.0	157.7	98.6	158.6	99.1	159.4	99.6	160.3	100.2	161.1	100.7	58
33	154.3	100.2	155.2	100.8	156.0	101.3	156.8	101.8	157.7	102.4	158.5	102.9	159.3	103.5	57
34	152.5	102.9	153.4	103.5	154.2	104.0	155.0	104.6	155.9	105.1	156.7	105.7	157.5	106.2	56
35	150.7	105.5	151.5	106.1	152.4	106.7	153.2	107.3	154.0	107.8	154.8	108.4	155.6	109.0	55
36	148.9	108.2	149.7	108.7	150.5	109.3	151.3	109.9	152.1	110.5	152.9	111.1	153.7	111.7	54
37	146.9	110.7	147.7	111.3	148.5	111.9	149.3	112.5	150.1	113.1	150.9	113.7	151.7	114.3	53
38	145.0	113.3	145.8	113.9	146.6	114.5	147.4	115.1	148.1	115.7	148.9	116.4	149.7	117.0	52
39	143.0	115.8	143.8	116.4	144.5	117.1	145.3	117.7	146.1	118.3	146.9	118.9	147.7	119.6	51
40	141.0	118.3	141.7	118.9	142.5	119.6	143.3	120.2	144.0	120.8	144.8	121.5	145.5	122.1	50
41	138.9	120.7	139.6	121.4	140.4	122.0	141.1	122.7	141.9	123.3	142.6	124.0	143.4	124.7	49
42	136.7	123.1	137.5	123.8	138.2	124.5	139.0	125.1	139.7	125.8	140.5	126.5	141.2	127.1	48
43	134.6	125.5	135.3	126.2	136.0	126.9	136.8	127.5	137.5	128.2	138.2	128.9	139.0	129.6	47
44	132.4	127.8	133.1	128.5	133.8	129.2	134.5	129.9	135.2	130.6	136.0	131.3	136.7	132.0	46
45	130.1	130.1	130.8	130.8	131.5	131.5	132.2	132.2	132.9	132.9	133.6	133.6	134.4	134.4	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	D = 184′		D = 185′		D = 186′		D = 187′		D = 188′		D = 189′		D = 190′		

Plane Traverse Table

Course.	$D = 191'$		$D = 192'$		$D = 193'$		$D = 194'$		$D = 195'$		$D = 196'$		$D = 197'$		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	191.0	0.0	192.0	0.0	193.0	0.0	194.0	0.0	195.0	0.0	196.0	0.0	197.0	0.0	90
1	191.0	3.3	192.0	3.4	193.0	3.4	194.0	3.4	195.0	3.4	196.0	3.4	197.0	3.4	89
2	190.9	6.7	191.9	6.7	192.9	6.7	193.9	6.8	194.9	6.8	195.9	6.8	196.9	6.9	88
3	190.7	10.0	191.7	10.0	192.7	10.1	193.7	10.2	194.7	10.2	195.7	10.3	196.7	10.3	87
4	190.5	13.3	191.5	13.4	192.5	13.5	193.5	13.5	194.5	13.6	195.5	13.7	196.5	13.7	86
5	190.3	16.6	191.3	16.7	192.3	16.8	193.3	16.9	194.3	17.0	195.3	17.1	196.3	17.2	85
6	190.0	20.0	190.9	20.1	191.9	20.2	192.9	20.3	193.9	20.4	194.9	20.5	195.9	20.6	84
7	189.6	23.3	190.6	23.4	191.6	23.5	192.6	23.6	193.5	23.8	194.5	23.9	195.5	24.0	83
8	189.1	26.6	190.1	26.7	191.1	26.9	192.1	27.0	193.1	27.1	194.1	27.3	195.1	27.4	82
9	188.6	29.9	189.6	30.0	190.6	30.2	191.6	30.3	192.6	30.5	193.6	30.7	194.6	30.8	81
10	188.1	33.2	189.1	33.3	190.1	33.5	191.1	33.7	192.0	33.9	193.0	34.0	194.0	34.2	80
11	187.5	36.4	188.5	36.6	189.5	36.8	190.4	37.0	191.4	37.2	192.4	37.4	193.4	37.6	79
12	186.8	39.7	187.8	39.9	188.8	40.1	189.8	40.3	190.7	40.5	191.7	40.8	192.7	41.0	78
13	186.1	43.0	187.1	43.2	188.1	43.4	189.0	43.6	190.0	43.9	191.0	44.1	192.0	44.3	77
14	185.3	46.2	186.3	46.4	187.3	46.7	188.2	46.9	189.2	47.2	190.2	47.4	191.1	47.7	76
15	184.5	49.4	185.5	49.7	186.4	50.0	187.4	50.2	188.4	50.5	189.3	50.7	190.3	51.0	75
16	183.6	52.6	184.6	52.9	185.5	53.2	186.5	53.5	187.4	53.7	188.4	54.0	189.4	54.3	74
17	182.7	55.8	183.6	56.1	184.6	56.4	185.5	56.7	186.5	57.0	187.4	57.3	188.4	57.6	73
18	181.7	59.0	182.6	59.3	183.6	59.6	184.5	59.9	185.5	60.3	186.4	60.6	187.4	60.9	72
19	180.6	62.2	181.5	62.5	182.5	62.8	183.4	63.2	184.4	63.5	185.3	63.8	186.3	64.1	71
20	179.5	65.3	180.4	65.7	181.4	66.0	182.3	66.4	183.2	66.7	184.2	67.0	185.1	67.4	70
21	178.3	68.4	179.2	68.8	180.2	69.2	181.1	69.5	182.0	69.9	183.0	70.2	183.9	70.6	69
22	177.1	71.5	178.0	71.9	178.9	72.3	179.9	72.7	180.8	73.0	181.7	73.4	182.7	73.8	68
23	175.8	74.6	176.7	75.0	177.7	75.4	178.6	75.8	179.5	76.2	180.4	76.6	181.3	77.0	67
24	174.5	77.7	175.4	78.1	176.3	78.5	177.2	78.9	178.1	79.3	179.1	79.7	180.0	80.1	66
25	173.1	80.7	174.0	81.1	174.9	81.6	175.8	82.0	176.7	82.4	177.6	82.8	178.5	83.3	65
26	171.7	83.7	172.6	84.2	173.5	84.6	174.4	85.0	175.3	85.5	176.2	85.9	177.1	86.4	64
27	170.2	86.7	171.1	87.2	172.0	87.6	172.9	88.1	173.7	88.5	174.6	89.0	175.5	89.4	63
28	168.6	89.7	169.5	90.1	170.4	90.6	171.3	91.1	172.2	91.5	173.1	92.0	173.9	92.5	62
29	167.1	92.6	167.9	93.1	168.8	93.6	169.7	94.1	170.6	94.5	171.4	95.0	172.3	95.5	61
30	165.4	95.5	166.3	96.0	167.1	96.5	168.0	97.0	168.9	97.5	169.7	98.0	170.6	98.5	60
31	163.7	98.4	164.6	98.9	165.4	99.4	166.3	99.9	167.1	100.4	168.0	100.9	168.9	101.5	59
32	162.0	101.2	162.8	101.7	163.7	102.3	164.5	102.8	165.4	103.3	166.2	103.9	167.1	104.4	58
33	160.2	104.0	161.0	104.6	161.9	105.1	162.7	105.7	163.5	106.2	164.4	106.7	165.2	107.3	57
34	158.3	106.8	159.2	107.4	160.0	107.9	160.8	108.5	161.7	109.0	162.5	109.6	163.3	110.2	56
35	156.5	109.6	157.3	110.1	158.1	110.7	158.9	111.3	159.7	111.8	160.6	112.4	161.4	113.0	55
36	154.4	112.3	155.3	112.9	156.1	113.4	156.9	114.0	157.8	114.6	158.6	115.2	159.4	115.8	54
37	152.5	114.9	153.3	115.5	154.1	116.2	154.9	116.8	155.7	117.4	156.5	118.0	157.3	118.6	53
38	150.5	117.6	151.3	118.2	152.1	118.8	152.9	119.4	153.7	120.1	154.5	120.7	155.2	121.3	52
39	148.4	120.2	149.2	120.8	150.0	121.5	150.8	122.1	151.5	122.7	152.3	123.3	153.1	124.0	51
40	146.3	122.8	147.1	123.4	147.8	124.1	148.6	124.7	149.4	125.3	150.1	126.0	150.9	126.6	50
41	144.1	125.3	144.9	126.0	145.7	126.6	146.4	127.3	147.2	127.9	147.9	128.6	148.7	129.2	49
42	141.9	127.8	142.7	128.5	143.4	129.1	144.2	129.8	144.9	130.5	145.7	131.1	146.4	131.8	48
43	139.7	130.3	140.4	130.9	141.2	131.6	141.9	132.3	142.6	133.0	143.3	133.7	144.1	134.4	47
44	137.4	132.7	138.1	133.4	138.8	134.1	139.6	134.8	140.3	135.5	141.0	136.2	141.7	136.8	46
45	135.1	135.1	135.8	135.8	136.5	136.5	137.2	137.2	137.9	137.9	138.6	138.6	139.3	139.3	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	$D = 191'$		$D = 192'$		$D = 193'$		$D = 194'$		$D = 195'$		$D = 196'$		$D = 197'$		

Plane Traverse Table

Course.	D = 198′		D = 199′		D = 200′		D = 201′		D = 202′		D = 203′		D = 204′		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	198.0	0.0	199.0	0.0	200.0	0.0	201.0	0.0	202.0	0.0	203.0	0.0	204.0	0.0	90
1	198.0	3.5	199.0	3.5	200.0	3.5	201.0	3.5	202.0	3.5	203.0	3.5	204.0	3.6	89
2	197.9	6.9	198.9	6.9	199.9	7.0	200.9	7.0	201.9	7.0	202.9	7.1	203.9	7.1	88
3	197.7	10.4	198.7	10.4	199.7	10.5	200.7	10.5	201.7	10.6	202.7	10.6	203.7	10.7	87
4	197.5	13.8	198.5	13.9	199.5	14.0	200.5	14.0	201.5	14.1	202.5	14.2	203.5	14.2	86
5	197.2	17.3	198.2	17.3	199.2	17.4	200.2	17.5	201.2	17.6	202.2	17.7	203.2	17.8	85
6	196.9	20.7	197.9	20.8	198.9	20.9	199.9	21.0	200.9	21.1	201.9	21.2	202.9	21.3	84
7	196.5	24.1	197.5	24.3	198.5	24.4	199.5	24.5	200.5	24.6	201.5	24.7	202.5	24.9	83
8	196.1	27.6	197.1	27.7	198.1	27.8	199.0	28.0	200.0	28.1	201.0	28.3	202.0	28.4	82
9	195.6	31.0	196.5	31.1	197.5	31.3	198.5	31.4	199.5	31.6	200.5	31.8	201.5	31.9	81
10	195.0	34.4	196.0	34.6	197.0	34.7	197.9	34.9	198.9	35.1	199.9	35.3	200.9	35.4	80
11	194.4	37.8	195.3	38.0	196.3	38.2	197.3	38.4	198.3	38.5	199.3	38.7	200.3	38.9	79
12	193.7	41.2	194.7	41.4	195.6	41.6	196.6	41.8	197.6	42.0	198.6	42.2	199.5	42.4	78
13	192.9	44.5	193.9	44.8	194.9	45.0	195.8	45.2	196.8	45.4	197.8	45.7	198.8	45.9	77
14	192.1	47.9	193.1	48.1	194.1	48.4	195.0	48.6	196.0	48.9	197.0	49.1	197.9	49.4	76
15	191.3	51.2	192.2	51.5	193.2	51.8	194.2	52.0	195.1	52.3	196.1	52.5	197.0	52.8	75
16	190.3	54.6	191.3	54.9	192.3	55.1	193.2	55.4	194.2	55.7	195.1	56.0	196.1	56.2	74
17	189.3	57.9	190.3	58.2	191.3	58.5	192.2	58.8	193.2	59.1	194.1	59.4	195.1	59.6	73
18	188.3	61.2	189.3	61.5	190.2	61.8	191.2	62.1	192.1	62.4	193.1	62.7	194.0	63.0	72
19	187.2	64.5	188.2	64.8	189.1	65.1	190.0	65.4	191.0	65.8	191.9	66.1	192.9	66.4	71
20	186.1	67.7	187.0	68.1	187.9	68.4	188.9	68.7	189.8	69.1	190.8	69.4	191.7	69.8	70
21	184.8	71.0	185.8	71.3	186.7	71.7	187.6	72.0	188.6	72.4	189.5	72.7	190.5	73.1	69
22	183.6	74.2	184.5	74.5	185.4	74.9	186.4	75.3	187.3	75.7	188.2	76.0	189.1	76.4	68
23	182.3	77.4	183.2	77.8	184.1	78.1	185.0	78.5	185.9	78.9	186.9	79.3	187.8	79.7	67
24	180.9	80.5	181.8	80.9	182.7	81.3	183.6	81.8	184.5	82.2	185.4	82.6	186.4	83.0	66
25	179.4	83.7	180.4	84.1	181.3	84.5	182.2	84.9	183.1	85.4	184.0	85.8	184.9	86.2	65
26	178.0	86.8	178.9	87.2	179.8	87.7	180.7	88.1	181.6	88.6	182.5	89.0	183.4	89.4	64
27	176.4	89.9	177.3	90.3	178.2	90.8	179.1	91.3	180.0	91.7	180.9	92.2	181.8	92.6	63
28	174.8	93.0	175.7	93.4	176.6	93.9	177.5	94.4	178.4	94.8	179.2	95.3	180.1	95.8	62
29	173.2	96.0	174.0	96.5	174.9	97.0	175.8	97.4	176.7	97.9	177.5	98.4	178.4	98.9	61
30	171.5	99.0	172.3	99.5	173.2	100.0	174.1	100.5	174.9	101.0	175.8	101.5	176.7	102.0	60
31	169.7	102.0	170.6	102.5	171.4	103.0	172.3	103.5	173.1	104.0	174.0	104.6	174.9	105.1	59
32	167.9	104.9	168.8	105.5	169.6	106.0	170.5	106.5	171.3	107.0	172.2	107.6	173.0	108.1	58
33	166.1	107.8	166.9	108.4	167.7	108.9	168.6	109.5	169.4	110.0	170.3	110.6	171.1	111.1	57
34	164.1	110.7	165.0	111.3	165.8	111.8	166.6	112.4	167.5	113.0	168.3	113.5	169.1	114.1	56
35	162.2	113.6	163.0	114.1	163.8	114.7	164.6	115.3	165.5	115.9	166.3	116.4	167.1	117.0	55
36	160.2	116.4	161.0	117.0	161.8	117.6	162.6	118.1	163.4	118.7	164.2	119.3	165.0	119.9	54
37	158.1	119.2	158.9	119.8	159.7	120.4	160.5	121.0	161.3	121.6	162.1	122.2	162.9	122.8	53
38	156.0	121.9	156.8	122.5	157.6	123.1	158.4	123.7	159.2	124.4	160.0	125.0	160.8	125.6	52
39	153.9	124.6	154.7	125.2	155.4	125.9	156.2	126.5	157.0	127.1	157.8	127.8	158.5	128.4	51
40	151.7	127.3	152.4	127.9	153.2	128.6	154.0	129.2	154.7	129.8	155.5	130.5	156.3	131.1	50
41	149.4	129.9	150.2	130.6	150.9	131.2	151.7	131.9	152.5	132.5	153.2	133.2	154.0	133.8	49
42	147.1	132.5	147.9	133.2	148.6	133.8	149.4	134.5	150.1	135.2	150.9	135.8	151.6	136.5	48
43	144.8	135.0	145.5	135.7	146.3	136.4	147.0	137.1	147.7	137.8	148.5	138.4	149.2	139.1	47
44	142.4	137.5	143.1	138.2	143.9	138.9	144.6	139.6	145.3	140.3	146.0	141.0	146.7	141.7	46
45	140.0	140.0	140.7	140.7	141.4	141.4	142.1	142.1	142.8	142.8	143.5	143.5	144.2	144.2	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	D = 198′		D = 199′		D = 200′		D = 201′		D = 202′		D = 203′		D = 204′		

Plane Traverse Table

Course.	$D=205'$		$D=206'$		$D=207'$		$D=208'$		$D=209'$		$D=210'$		$D=211'$		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	205.0	0.0	206.0	0.0	207.0	0.0	208.0	0.0	209.0	0.0	210.0	0.0	211.0	0.0	90
1	205.0	3.6	206.0	3.6	207.0	3.6	208.0	3.6	209.0	3.6	210.0	3.7	211.0	3.7	89
2	204.9	7.2	205.9	7.2	206.9	7.2	207.9	7.3	208.9	7.3	209.9	7.3	210.9	7.4	88
3	204.7	10.7	205.7	10.8	206.7	10.8	207.7	10.9	208.7	10.9	209.7	11.0	210.7	11.0	87
4	204.5	14.3	205.5	14.4	206.5	14.4	207.5	14.5	208.5	14.6	209.5	14.6	210.5	14.7	86
5	204.2	17.9	205.2	18.0	206.2	18.0	207.2	18.1	208.2	18.2	209.2	18.3	210.2	18.4	85
6	203.9	21.4	204.9	21.5	205.9	21.6	206.9	21.7	207.9	21.8	208.8	22.0	209.8	22.1	84
7	203.5	25.0	204.5	25.1	205.5	25.2	206.4	25.3	207.4	25.5	208.4	25.6	209.4	25.7	83
8	203.0	28.5	204.0	28.7	205.0	28.8	206.0	28.9	207.0	29.1	208.0	29.2	208.9	29.4	82
9	202.5	32.1	203.5	32.2	204.5	32.4	205.4	32.5	206.4	32.7	207.4	32.9	208.4	33.0	81
10	201.9	35.6	202.9	35.8	203.9	35.9	204.8	36.1	205.8	36.3	206.8	36.5	207.8	36.6	80
11	201.2	39.1	202.2	39.3	203.2	39.5	204.2	39.7	205.2	39.9	206.1	40.1	207.1	40.3	79
12	200.5	42.6	201.5	42.8	202.5	43.0	203.5	43.2	204.4	43.5	205.4	43.7	206.4	43.9	78
13	199.7	46.1	200.7	46.3	201.7	46.6	202.7	46.8	203.6	47.0	204.6	47.2	205.6	47.5	77
14	198.9	49.6	199.9	49.8	200.9	50.1	201.8	50.3	202.8	50.6	203.8	50.8	204.7	51.0	76
15	198.0	53.1	199.0	53.3	199.9	53.6	200.9	53.8	201.9	54.1	202.8	54.4	203.8	54.6	75
16	197.1	56.5	198.0	56.8	199.0	57.1	199.9	57.3	200.9	57.6	201.9	57.9	202.8	58.2	74
17	196.0	59.9	197.0	60.2	198.0	60.5	198.9	60.8	199.9	61.1	200.8	61.4	201.8	61.7	73
18	195.0	63.3	195.9	63.7	196.9	64.0	197.8	64.3	198.8	64.6	199.7	64.9	200.7	65.2	72
19	193.8	66.7	194.8	67.1	195.7	67.4	196.7	67.7	197.6	68.0	198.6	68.4	199.5	68.7	71
20	192.6	70.1	193.6	70.5	194.5	70.8	195.5	71.1	196.4	71.5	197.3	71.8	198.3	72.2	70
21	191.4	73.5	192.3	73.8	193.3	74.2	194.2	74.5	195.1	74.9	196.1	75.3	197.0	75.6	69
22	190.1	76.8	191.0	77.2	191.9	77.5	192.9	77.9	193.8	78.3	194.7	78.7	195.6	79.0	68
23	188.7	80.1	189.6	80.5	190.5	80.9	191.5	81.3	192.4	81.7	193.3	82.1	194.2	82.4	67
24	187.3	83.4	188.2	83.8	189.1	84.2	190.0	84.6	190.9	85.0	191.8	85.4	192.8	85.8	66
25	185.8	86.6	186.7	87.1	187.6	87.5	188.5	87.9	189.4	88.3	190.3	88.7	191.2	89.2	65
26	184.3	89.9	185.2	90.3	186.1	90.7	186.9	91.2	187.8	91.6	188.7	92.1	189.6	92.5	64
27	182.7	93.1	183.5	93.5	184.4	94.0	185.3	94.4	186.2	94.9	187.1	95.3	188.0	95.8	63
28	181.0	96.2	181.9	96.7	182.8	97.2	183.7	97.7	184.5	98.1	185.4	98.6	186.3	99.1	62
29	179.3	99.4	180.2	99.9	181.0	100.4	181.9	100.8	182.8	101.3	183.7	101.8	184.5	102.3	61
30	177.5	102.5	178.4	103.0	179.3	103.5	180.1	104.0	181.0	104.5	181.9	105.0	182.7	105.5	60
31	175.7	105.6	176.6	106.1	177.4	106.6	178.3	107.1	179.1	107.6	180.0	108.2	180.9	108.7	59
32	173.8	108.6	174.7	109.2	175.5	109.7	176.4	110.2	177.2	110.8	178.1	111.3	178.9	111.8	58
33	171.9	111.7	172.8	112.2	173.6	112.7	174.4	113.3	175.3	113.8	176.1	114.4	177.0	114.9	57
34	170.0	114.6	170.8	115.2	171.6	115.8	172.4	116.3	173.3	116.9	174.1	117.4	174.9	118.0	56
35	167.9	117.6	168.7	118.2	169.6	118.7	170.4	119.3	171.2	119.9	172.0	120.5	172.8	121.0	55
36	165.8	120.5	166.7	121.1	167.5	121.7	168.3	122.3	169.1	122.8	169.9	123.4	170.7	124.0	54
37	163.7	123.4	164.5	124.0	165.3	124.6	166.1	125.2	166.9	125.8	167.7	126.4	168.5	127.0	53
38	161.5	126.2	162.3	126.8	163.1	127.4	163.9	128.1	164.7	128.7	165.5	129.3	166.3	129.9	52
39	159.3	129.0	160.1	129.6	160.9	130.3	161.6	130.9	162.4	131.5	163.2	132.2	164.0	132.8	51
40	157.0	131.8	157.8	132.4	158.6	133.1	159.3	133.7	160.1	134.3	160.9	135.0	161.6	135.6	50
41	154.7	134.5	155.5	135.1	156.2	135.8	157.0	136.5	157.7	137.1	158.5	137.8	159.2	138.4	49
42	152.3	137.2	153.1	137.8	153.8	138.5	154.6	139.2	155.3	139.8	156.1	140.5	156.8	141.2	48
43	149.9	139.8	150.7	140.5	151.4	141.2	152.1	141.9	152.9	142.5	153.6	143.2	154.3	143.9	47
44	147.5	142.4	148.2	143.1	148.9	143.8	149.6	144.5	150.3	145.2	151.1	145.9	151.8	146.6	46
45	145.0	145.0	145.7	145.7	146.4	146.4	147.1	147.1	147.8	147.8	148.5	148.5	149.2	149.2	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	$D=205'$		$D=206'$		$D=207'$		$D=208'$		$D=209'$		$D=210'$		$D=211'$		

Plane Traverse Table

Course.	D=212′		D=213′		D=214′		D=215′		D=216′		D=217′		D=218′		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	212.0	0.0	213.0	0.0	214.0	0.0	215.0	0.0	216.0	0.0	217.0	0.0	218.0	0.0	90
1	212.0	3.7	213.0	3.7	214.0	3.7	215.0	3.8	216.0	3.8	217.0	3.8	218.0	3.8	89
2	211.9	7.4	212.9	7.4	213.9	7.5	214.9	7.5	215.9	7.5	216.9	7.6	217.9	7.6	88
3	211.7	11.1	212.7	11.1	213.7	11.2	214.7	11.3	215.7	11.3	216.7	11.4	217.7	11.4	87
4	211.5	14.8	212.5	14.9	213.5	14.9	214.5	15.0	215.5	15.1	216.5	15.1	217.5	15.2	86
5	211.2	18.5	212.2	18.6	213.2	18.7	214.2	18.7	215.2	18.8	216.2	18.9	217.2	19.0	85
6	210.8	22.2	211.8	22.3	212.8	22.4	213.8	22.5	214.8	22.6	215.8	22.7	216.8	22.8	84
7	210.4	25.8	211.4	26.0	212.4	26.1	213.4	26.2	214.4	26.3	215.4	26.4	216.4	26.6	83
8	209.9	29.5	210.9	29.6	211.9	29.8	212.9	29.9	213.9	30.1	214.9	30.2	215.9	30.3	82
9	209.4	33.2	210.4	33.3	211.4	33.5	212.4	33.6	213.3	33.8	214.3	33.9	215.3	34.1	81
10	208.8	36.8	209.8	37.0	210.7	37.2	211.7	37.3	212.7	37.5	213.7	37.7	214.7	37.9	80
11	208.1	40.5	209.1	40.6	210.1	40.8	211.0	41.0	212.0	41.2	213.0	41.4	214.0	41.6	79
12	207.4	44.1	208.3	44.3	209.3	44.5	210.3	44.7	211.3	44.9	212.3	45.1	213.2	45.3	78
13	206.6	47.7	207.5	47.9	208.5	48.1	209.5	48.4	210.5	48.6	211.4	48.8	212.4	49.0	77
14	205.7	51.3	206.7	51.5	207.6	51.8	208.6	52.0	209.6	52.3	210.6	52.5	211.5	52.7	76
15	204.8	54.9	205.7	55.1	206.7	55.4	207.7	55.6	208.6	55.9	209.6	56.2	210.6	56.4	75
16	203.8	58.4	204.7	58.7	205.7	59.0	206.7	59.3	207.6	59.5	208.6	59.8	209.6	60.1	74
17	202.7	62.0	203.7	62.3	204.6	62.6	205.6	62.9	206.6	63.2	207.5	63.4	208.5	63.7	73
18	201.6	65.5	202.6	65.8	203.5	66.1	204.5	66.4	205.4	66.7	206.4	67.1	207.3	67.4	72
19	200.4	69.0	201.4	69.3	202.3	69.7	203.3	70.0	204.2	70.3	205.2	70.6	206.1	71.0	71
20	199.2	72.5	200.2	72.9	201.1	73.2	202.0	73.5	203.0	73.9	203.9	74.2	204.9	74.6	70
21	197.9	76.0	198.9	76.3	199.8	76.7	200.7	77.0	201.7	77.4	202.6	77.8	203.5	78.1	69
22	196.6	79.4	197.5	79.8	198.4	80.2	199.3	80.5	200.3	80.9	201.2	81.3	202.1	81.7	68
23	195.1	82.8	196.1	83.2	197.0	83.6	197.9	84.0	198.8	84.4	199.7	84.8	200.7	85.2	67
24	193.7	86.2	194.6	86.6	195.5	87.0	196.4	87.4	197.3	87.9	198.2	88.3	199.2	88.7	66
25	192.1	89.6	193.0	90.0	193.9	90.4	194.9	90.9	195.8	91.3	196.7	91.7	197.6	92.1	65
26	190.5	92.9	191.4	93.4	192.3	93.8	193.2	94.2	194.1	94.7	195.0	95.1	195.9	95.6	64
27	188.9	96.2	189.8	96.7	190.7	97.2	191.6	97.6	192.5	98.1	193.3	98.5	194.2	99.0	63
28	187.2	99.5	188.1	100.0	189.0	100.5	189.8	100.9	190.7	101.4	191.6	101.9	192.5	102.3	62
29	185.4	102.8	186.3	103.3	187.2	103.7	188.0	104.2	188.9	104.7	189.8	105.2	190.7	105.7	61
30	183.6	106.0	184.5	106.5	185.3	107.0	186.2	107.5	187.1	108.0	187.9	108.5	188.8	109.0	60
31	181.7	109.2	182.6	109.7	183.4	110.2	184.3	110.7	185.1	111.2	186.0	111.8	186.9	112.3	59
32	179.8	112.3	180.6	112.9	181.5	113.4	182.3	113.9	183.2	114.5	184.0	115.0	184.9	115.5	58
33	177.8	115.5	178.6	116.0	179.5	116.6	180.3	117.1	181.2	117.6	182.0	118.2	182.8	118.7	57
34	175.8	118.5	176.6	119.1	177.4	119.7	178.2	120.2	179.1	120.8	179.9	121.3	180.7	121.9	56
35	173.7	121.6	174.5	122.2	175.3	122.7	176.1	123.3	176.9	123.9	177.8	124.5	178.6	125.0	55
36	171.5	124.6	172.3	125.2	173.1	125.8	173.9	126.4	174.7	127.0	175.6	127.5	176.4	128.1	54
37	169.3	127.6	170.1	128.2	170.9	128.8	171.7	129.4	172.5	130.0	173.3	130.6	174.1	131.2	53
38	167.1	130.5	167.8	131.1	168.6	131.8	169.4	132.4	170.2	133.0	171.0	133.6	171.8	134.2	52
39	164.8	133.4	165.5	134.0	166.3	134.7	167.1	135.3	167.9	135.9	168.6	136.6	169.4	137.2	51
40	162.4	136.3	163.2	136.9	163.9	137.6	164.7	138.2	165.5	138.8	166.2	139.5	167.0	140.1	50
41	160.0	139.1	160.8	139.7	161.5	140.4	162.3	141.1	163.0	141.7	163.8	142.4	164.5	143.0	49
42	157.5	141.9	158.3	142.5	159.0	143.2	159.8	143.9	160.5	144.5	161.3	145.2	162.0	145.9	48
43	155.0	144.6	155.8	145.3	156.5	145.9	157.2	146.6	158.0	147.3	158.7	148.0	159.4	148.7	47
44	152.5	147.3	153.2	148.0	153.9	148.7	154.7	149.4	155.4	150.0	156.1	150.7	156.8	151.4	46
45	149.9	149.9	150.6	150.6	151.3	151.3	152.0	152.0	152.7	152.7	153.4	153.4	154.1	154.1	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	D=212′		D=213′		D=214′		D=215′		D=216′		D=217′		D=218′		

Plane Traverse Table

Course.	$D=219'$		$D=220'$		$D=221'$		$D=222'$		$D=223'$		$D=224'$		$D=225'$		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	219.0	0.0	220.0	0.0	221.0	0.0	222.0	0.0	223.0	0.0	224.0	0.0	225.0	0.0	90
1	219.0	3.8	220.0	3.8	221.0	3.9	222.0	3.9	223.0	3.9	224.0	3.9	225.0	3.9	89
2	218.9	7.6	219.9	7.7	220.9	7.7	221.9	7.7	222.9	7.8	223.9	7.8	224.9	7.9	88
3	218.7	11.5	219.7	11.5	220.7	11.6	221.7	11.6	222.7	11.7	223.7	11.7	224.7	11.8	87
4	218.5	15.3	219.5	15.3	220.5	15.4	221.5	15.5	222.5	15.6	223.5	15.6	224.5	15.7	86
5	218.2	19.1	219.2	19.2	220.2	19.3	221.2	19.3	222.2	19.4	223.1	19.5	224.1	19.6	85
6	217.8	22.9	218.8	23.0	219.8	23.1	220.8	23.2	221.8	23.3	222.8	23.4	223.8	23.5	84
7	217.4	26.7	218.4	26.8	219.4	26.9	220.3	27.1	221.3	27.2	222.3	27.3	223.3	27.4	83
8	216.9	30.5	217.9	30.6	218.8	30.8	219.8	30.9	220.8	31.0	221.8	31.2	222.8	31.3	82
9	216.3	34.3	217.3	34.4	218.3	34.6	219.3	34.7	220.3	34.9	221.2	35.0	222.2	35.2	81
10	215.7	38.0	216.7	38.2	217.6	38.4	218.6	38.5	219.6	38.7	220.6	38.9	221.6	39.1	80
11	215.0	41.8	216.0	42.0	216.9	42.2	217.9	42.4	218.9	42.6	219.9	42.7	220.9	42.9	79
12	214.2	45.5	215.2	45.7	216.2	45.9	217.1	46.2	218.1	46.4	219.1	46.6	220.1	46.8	78
13	213.4	49.3	214.4	49.5	215.3	49.7	216.3	49.9	217.3	50.2	218.3	50.4	219.2	50.6	77
14	212.5	53.0	213.5	53.2	214.4	53.5	215.4	53.7	216.4	53.9	217.3	54.2	218.3	54.4	76
15	211.5	56.7	212.5	56.9	213.5	57.2	214.4	57.5	215.4	57.7	216.4	58.0	217.3	58.2	75
16	210.5	60.4	211.5	60.6	212.4	60.9	213.4	61.2	214.4	61.5	215.3	61.7	216.3	62.0	74
17	209.4	64.0	210.4	64.3	211.3	64.6	212.3	64.9	213.3	65.2	214.2	65.5	215.2	65.8	73
18	208.3	67.7	209.2	68.0	210.2	68.3	211.1	68.6	212.1	68.9	213.0	69.2	214.0	69.5	72
19	207.1	71.3	208.0	71.6	209.0	72.0	209.9	72.3	210.9	72.6	211.8	72.9	212.7	73.3	71
20	205.8	74.9	206.7	75.2	207.7	75.6	208.6	75.9	209.6	76.3	210.5	76.6	211.4	77.0	70
21	204.5	78.5	205.4	78.8	206.3	79.2	207.3	79.6	208.2	79.9	209.1	80.3	210.1	80.6	69
22	203.1	82.0	204.0	82.4	204.9	82.8	205.8	83.2	206.8	83.5	207.7	83.9	208.6	84.3	68
23	201.6	85.6	202.5	86.0	203.4	86.4	204.4	86.7	205.3	87.1	206.2	87.5	207.1	87.9	67
24	200.1	89.1	201.0	89.5	201.9	89.9	202.8	90.3	203.7	90.7	204.6	91.1	205.5	91.5	66
25	198.5	92.6	199.4	93.0	200.3	93.4	201.2	93.8	202.1	94.2	203.0	94.7	203.9	95.1	65
26	196.8	96.0	197.7	96.4	198.6	96.9	199.5	97.3	200.4	97.8	201.3	98.2	202.2	98.6	64
27	195.1	99.4	196.0	99.9	196.9	100.3	197.8	100.8	198.7	101.2	199.6	101.7	200.5	102.1	63
28	193.4	102.8	194.2	103.3	195.1	103.8	196.0	104.2	196.9	104.7	197.8	105.2	198.7	105.6	62
29	191.5	106.2	192.4	106.7	193.3	107.1	194.2	107.6	195.0	108.1	195.9	108.6	196.8	109.1	61
30	189.7	109.5	190.5	110.0	191.4	110.5	192.3	111.0	193.1	111.5	194.0	112.0	194.9	112.5	60
31	187.7	112.8	188.6	113.3	189.4	113.8	190.3	114.3	191.1	114.9	192.0	115.4	192.9	115.9	59
32	185.7	116.1	186.6	116.6	187.4	117.1	188.3	117.6	189.1	118.2	190.0	118.7	190.8	119.2	58
33	183.7	119.3	184.5	119.8	185.3	120.4	186.2	120.9	187.0	121.5	187.9	122.0	188.7	122.5	57
34	181.6	122.5	182.4	123.0	183.2	123.6	184.0	124.1	184.9	124.7	185.7	125.3	186.5	125.8	56
35	179.4	125.6	180.2	126.2	181.0	126.8	181.9	127.3	182.7	127.9	183.5	128.5	184.3	129.1	55
36	177.2	128.7	178.0	129.3	178.8	129.9	179.6	130.5	180.4	131.1	181.2	131.7	182.0	132.3	54
37	174.9	131.8	175.7	132.4	176.5	133.0	177.3	133.6	178.1	134.2	178.9	134.8	179.7	135.4	53
38	172.6	134.8	173.4	135.4	174.2	136.1	174.9	136.7	175.7	137.3	176.5	137.9	177.3	138.5	52
39	170.2	137.8	171.0	138.5	171.7	139.1	172.5	139.7	173.3	140.3	174.1	141.0	174.9	141.6	51
40	167.8	140.8	168.5	141.4	169.3	142.1	170.1	142.7	170.8	143.3	171.6	144.0	172.4	144.6	50
41	165.3	143.7	166.0	144.3	166.8	145.0	167.5	145.6	168.3	146.3	169.1	147.0	169.8	147.6	49
42	162.7	146.5	163.5	147.2	164.2	147.9	165.0	148.5	165.7	149.2	166.5	149.9	167.2	150.6	48
43	160.2	149.4	160.9	150.0	161.6	150.7	162.4	151.4	163.1	152.1	163.8	152.8	164.6	153.4	47
44	157.5	152.1	158.3	152.8	159.0	153.5	159.7	154.2	160.4	154.9	161.1	155.6	161.9	156.3	46
45	154.9	154.9	155.6	155.6	156.3	156.3	157.0	157.0	157.7	157.7	158.4	158.4	159.1	159.1	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	$D=219'$		$D=220'$		$D=221'$		$D=222'$		$D=223'$		$D=224'$		$D=225'$		

Plane Traverse Table

Course.	D=226′		D=227′		D=228′		D=229′		D=230′		D=231′		D=232′		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	226.0	0.0	227.0	0.0	228.0	0.0	229.0	0.0	230.0	0.0	231.0	0.0	232.0	0.0	90
1	226.0	3.9	227.0	4.0	228.0	4.0	229.0	4.0	230.0	4.0	231.0	4.0	232.0	4.0	89
2	225.9	7.9	226.9	7.9	227.9	8.0	228.9	8.0	229.9	8.0	230.9	8.1	231.9	8.1	88
3	225.7	11.8	226.7	11.9	227.7	11.9	228.7	12.0	229.7	12.0	230.7	12.1	231.7	12.1	87
4	225.4	15.7	226.4	15.8	227.4	15.9	228.4	16.0	229.4	16.0	230.4	16.1	231.4	16.2	86
5	225.1	19.8	226.1	19.8	227.1	19.9	228.1	20.0	229.1	20.0	230.1	20.1	231.1	20.2	85
6	224.8	23.6	225.8	23.7	226.8	23.8	227.7	23.9	228.7	24.0	229.7	24.1	230.7	24.3	84
7	224.3	27.5	225.3	27.7	226.3	27.8	227.3	27.9	228.3	28.0	229.3	28.1	230.3	28.3	83
8	223.8	31.5	224.8	31.6	225.8	31.7	226.8	31.9	227.8	32.0	228.8	32.1	229.7	32.3	82
9	223.2	35.4	224.2	35.5	225.2	35.7	226.2	35.8	227.2	36.0	228.2	36.1	229.1	36.3	81
10	222.6	39.2	223.6	39.4	224.5	39.6	225.5	39.8	226.5	39.9	227.5	40.1	228.5	40.3	80
11	221.8	43.1	222.8	43.3	223.8	43.5	224.8	43.7	225.8	43.9	226.8	44.1	227.7	44.3	79
12	221.1	47.0	222.0	47.2	223.0	47.4	224.0	47.6	225.0	47.8	226.0	48.0	226.9	48.2	78
13	220.2	50.8	221.2	51.1	222.2	51.3	223.1	51.5	224.1	51.7	225.1	52.0	226.1	52.2	77
14	219.3	54.7	220.3	54.9	221.2	55.2	222.2	55.4	223.2	55.6	224.1	55.9	225.1	56.1	76
15	218.3	58.5	219.3	58.8	220.2	59.0	221.2	59.3	222.2	59.5	223.1	59.8	224.1	60.0	75
16	217.2	62.3	218.2	62.6	219.2	62.8	220.1	63.1	221.1	63.4	222.1	63.7	223.0	63.9	74
17	216.1	66.1	217.1	66.4	218.0	66.7	219.0	67.0	220.0	67.2	220.9	67.5	221.9	67.8	73
18	214.9	69.8	215.9	70.1	216.8	70.5	217.8	70.8	218.7	71.1	219.7	71.4	220.6	71.7	72
19	213.7	73.6	214.6	73.9	215.6	74.2	216.5	74.6	217.5	74.9	218.4	75.2	219.4	75.5	71
20	212.4	77.3	213.3	77.6	214.2	78.0	215.2	78.3	216.1	78.7	217.1	79.0	218.0	79.3	70
21	211.0	81.0	211.9	81.3	212.9	81.7	213.8	82.1	214.7	82.4	215.7	82.8	216.6	83.1	69
22	209.5	84.7	210.5	85.0	211.4	85.4	212.3	85.8	213.3	86.2	214.2	86.5	215.1	86.9	68
23	208.0	88.3	209.0	88.7	209.9	89.1	210.8	89.5	211.7	89.9	212.6	90.3	213.6	90.6	67
24	206.5	91.9	207.4	92.3	208.3	92.7	209.2	93.1	210.1	93.5	211.0	94.0	211.9	94.4	66
25	204.8	95.5	205.7	95.9	206.6	96.4	207.5	96.8	208.5	97.2	209.4	97.6	210.3	98.0	65
26	203.1	99.1	204.0	99.5	204.9	99.9	205.8	100.4	206.7	100.8	207.6	101.3	208.5	101.7	64
27	201.4	102.6	202.3	103.1	203.1	103.5	204.0	104.0	204.9	104.4	205.8	104.9	206.7	105.3	63
28	199.5	106.1	200.4	106.6	201.3	107.0	202.2	107.5	203.1	108.0	204.0	108.4	204.8	108.9	62
29	197.7	109.6	198.5	110.1	199.4	110.5	200.3	111.0	201.2	111.5	202.0	112.0	202.9	112.5	61
30	195.7	113.0	196.6	113.5	197.5	114.0	198.3	114.5	199.2	115.0	200.1	115.5	200.9	116.0	60
31	193.7	116.4	194.6	116.9	195.4	117.4	196.3	117.9	197.1	118.5	198.0	119.0	198.9	119.5	59
32	191.7	119.8	192.5	120.3	193.4	120.8	194.2	121.4	195.1	121.9	195.9	122.4	196.7	122.9	58
33	189.5	123.1	190.4	123.6	191.2	124.2	192.1	124.7	192.9	125.3	193.7	125.8	194.6	126.4	57
34	187.4	126.4	188.2	126.9	189.0	127.5	189.8	128.1	190.7	128.6	191.5	129.2	192.3	129.7	56
35	185.1	129.6	185.9	130.2	186.8	130.8	187.6	131.3	188.4	131.9	189.2	132.5	190.0	133.1	55
36	182.8	132.8	183.6	133.4	184.5	134.0	185.3	134.6	186.1	135.2	186.9	135.8	187.7	136.4	54
37	180.5	136.0	181.3	136.6	182.1	137.2	182.9	137.8	183.7	138.4	184.5	139.0	185.3	139.6	53
38	178.1	139.1	178.9	139.8	179.7	140.4	180.5	141.0	181.2	141.6	182.0	142.2	182.8	142.8	52
39	175.6	142.2	176.4	142.9	177.2	143.5	178.0	144.1	178.7	144.7	179.5	145.4	180.3	146.0	51
40	173.1	145.3	173.9	145.9	174.7	146.6	175.4	147.2	176.2	147.8	177.0	148.5	177.7	149.1	50
41	170.6	148.3	171.3	148.9	172.1	149.6	172.8	150.2	173.6	150.9	174.3	151.5	175.1	152.2	49
42	168.0	151.2	168.7	151.9	169.4	152.6	170.2	153.2	170.9	153.9	171.7	154.6	172.4	155.2	48
43	165.3	154.1	166.0	154.8	166.7	155.5	167.5	156.2	168.2	156.9	168.9	157.5	169.7	158.2	47
44	162.6	157.0	163.3	157.7	164.0	158.4	164.7	159.1	165.4	159.8	166.2	160.5	166.9	161.2	46
45	159.8	159.8	160.5	160.5	161.2	161.2	161.9	161.9	162.6	162.6	163.3	163.3	164.0	164.0	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	D=226′		D=227′		D=228′		D=229′		D=230′		D=231′		D=232′		

Plane Traverse Table

Course.	D=233′		D=234′		D=235′		D=236′		D=237′		D=238′		D=239′		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	233.0	0.0	234.0	0.0	235.0	0.0	236.0	0.0	237.0	0.0	238.0	0.0	239.0	0.0	90
1	233.0	4.1	234.0	4.1	235.0	4.1	236.0	4.1	237.0	4.1	238.0	4.2	239.0	4.2	89
2	232.9	8.1	233.9	8.2	234.9	8.2	235.9	8.2	236.9	8.3	237.9	8.3	238.9	8.3	88
3	232.7	12.2	233.7	12.2	234.7	12.3	235.7	12.4	236.7	12.4	237.7	12.5	238.7	12.5	87
4	232.4	16.3	233.4	16.3	234.4	16.4	235.4	16.5	236.4	16.5	237.4	16.6	238.4	16.7	86
5	232.1	20.3	233.1	20.4	234.1	20.5	235.1	20.6	236.1	20.7	237.1	20.7	238.1	20.8	85
6	231.7	24.4	232.7	24.5	233.7	24.6	234.7	24.7	235.7	24.8	236.7	24.9	237.7	25.0	84
7	231.3	28.4	232.3	28.5	233.2	28.6	234.2	28.8	235.2	28.9	236.2	29.0	237.2	29.1	83
8	230.7	32.4	231.7	32.6	232.7	32.7	233.7	32.8	234.7	33.0	235.7	33.1	236.7	33.3	82
9	230.1	36.4	231.1	36.6	232.1	36.8	233.1	36.9	234.1	37.1	235.1	37.2	236.1	37.4	81
10	229.5	40.5	230.4	40.6	231.4	40.8	232.4	41.0	233.4	41.2	234.4	41.3	235.4	41.5	80
11	228.7	44.5	229.7	44.6	230.7	44.8	231.7	45.0	232.6	45.2	233.6	45.4	234.6	45.6	79
12	227.9	48.4	228.9	48.7	229.9	48.9	230.8	49.1	231.8	49.3	232.8	49.5	233.8	49.7	78
13	227.0	52.4	228.0	52.6	229.0	52.9	230.0	53.1	230.9	53.3	231.9	53.5	232.9	53.8	77
14	226.1	56.4	227.0	56.6	228.0	56.9	229.0	57.1	230.0	57.3	230.9	57.6	231.9	57.8	76
15	225.1	60.3	226.0	60.6	227.0	60.8	228.0	61.1	228.9	61.3	229.9	61.6	230.9	61.9	75
16	224.0	64.2	224.9	64.5	225.9	64.8	226.9	65.1	227.8	65.3	228.8	65.6	229.7	65.9	74
17	222.8	68.1	223.8	68.4	224.7	68.7	225.7	69.0	226.6	69.3	227.6	69.6	228.6	69.9	73
18	221.6	72.0	222.5	72.3	223.5	72.6	224.4	72.9	225.4	73.2	226.4	73.5	227.3	73.9	72
19	220.3	75.9	221.3	76.2	222.2	76.5	223.1	76.8	224.1	77.2	225.0	77.5	226.0	77.8	71
20	218.9	79.7	219.9	80.0	220.8	80.4	221.8	80.7	222.7	81.1	223.6	81.4	224.6	81.7	70
21	217.5	83.5	218.5	83.9	219.4	84.2	220.3	84.6	221.3	84.9	222.2	85.3	223.1	85.6	69
22	216.0	87.3	217.0	87.7	217.9	88.0	218.8	88.4	219.7	88.8	220.7	89.2	221.6	89.5	68
23	214.5	91.0	215.4	91.4	216.3	91.8	217.2	92.2	218.2	92.6	219.1	93.0	220.0	93.4	67
24	212.9	94.8	213.8	95.2	214.7	95.6	215.6	96.0	216.5	96.4	217.4	96.8	218.3	97.2	66
25	211.2	98.5	212.1	98.9	213.0	99.3	213.9	99.7	214.8	100.2	215.7	100.6	216.6	101.0	65
26	209.4	102.1	210.3	102.6	211.2	103.0	212.1	103.5	213.0	103.9	213.9	104.3	214.8	104.8	64
27	207.6	105.8	208.5	106.2	209.4	106.7	210.3	107.1	211.2	107.6	212.1	108.0	213.0	108.5	63
28	205.7	109.4	206.6	109.9	207.5	110.3	208.4	110.8	209.3	111.3	210.1	111.7	211.0	112.2	62
29	203.8	113.0	204.7	113.4	205.5	113.9	206.4	114.4	207.3	114.9	208.2	115.4	209.0	115.9	61
30	201.8	116.5	202.6	117.0	203.5	117.5	204.4	118.0	205.2	118.5	206.1	119.0	207.0	119.5	60
31	199.7	120.0	200.6	120.5	201.4	121.0	202.3	121.5	203.1	122.1	204.0	122.6	204.9	123.1	59
32	197.6	123.5	198.4	124.0	199.3	124.5	200.1	125.1	201.0	125.6	201.8	126.1	202.7	126.7	58
33	195.4	126.9	196.2	127.4	197.1	128.0	197.9	128.5	198.8	129.1	199.6	129.6	200.4	130.2	57
34	193.2	130.3	194.0	130.9	194.8	131.4	195.7	132.0	196.5	132.5	197.3	133.1	198.1	133.6	56
35	190.9	133.6	191.7	134.2	192.5	134.8	193.3	135.4	194.1	135.9	195.0	136.5	195.8	137.1	55
36	188.5	137.0	189.3	137.5	190.1	138.1	190.9	138.7	191.7	139.3	192.5	139.9	193.4	140.5	54
37	186.1	140.2	186.9	140.8	187.7	141.4	188.5	142.0	189.3	142.6	190.1	143.2	190.9	143.8	53
38	183.6	143.4	184.4	144.1	185.2	144.7	186.0	145.3	186.8	145.9	187.5	146.5	188.3	147.1	52
39	181.1	146.6	181.9	147.3	182.6	147.9	183.4	148.5	184.2	149.1	185.0	149.8	185.7	150.4	51
40	178.5	149.8	179.3	150.4	180.0	151.1	180.8	151.7	181.6	152.3	182.3	153.0	183.1	153.6	50
41	175.8	152.9	176.6	153.5	177.4	154.2	178.1	154.8	178.9	155.5	179.6	156.1	180.4	156.8	49
42	173.2	155.9	173.9	156.6	174.6	157.2	175.4	157.9	176.1	158.6	176.9	159.3	177.6	159.9	48
43	170.4	158.9	171.1	159.6	171.9	160.3	172.6	161.0	173.3	161.6	174.1	162.3	174.8	163.0	47
44	167.6	161.9	168.3	162.6	169.0	163.2	169.8	163.9	170.5	164.6	171.2	165.3	171.9	166.0	46
45	164.8	164.8	165.5	165.5	166.2	166.2	166.9	166.9	167.6	167.6	168.3	168.3	169.0	169.0	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	D=233′		D=234′		D=235′		D=236′		D=237′		D=238′		D=239′		

Plane Traverse Table

Course.	D=240′		D=241′		D=242′		D=243′		D=244′		D=245′		D=246′		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	240.0	0.0	241.0	0.0	242.0	0.0	243.0	0.0	244.0	0.0	245.0	0.0	246.0	0.0	90
1	240.0	4.2	241.0	4.2	242.0	4.2	243.0	4.2	244.0	4.3	245.0	4.3	246.0	4.3	89
2	239.9	8.4	240.9	8.4	241.9	8.4	242.9	8.5	243.9	8.5	244.9	8.6	245.9	8.6	88
3	239.7	12.6	240.7	12.6	241.7	12.7	242.7	12.7	243.7	12.8	244.7	12.8	245.7	12.9	87
4	239.4	16.7	240.4	16.8	241.4	16.9	242.4	17.0	243.4	17.0	244.4	17.1	245.4	17.2	86
5	239.1	20.9	240.1	21.0	241.1	21.1	242.1	21.2	243.1	21.3	244.1	21.4	245.1	21.4	85
6	238.7	25.1	239.7	25.2	240.7	25.3	241.7	25.4	242.7	25.5	243.7	25.6	244.7	25.7	84
7	238.2	29.2	239.2	29.4	240.2	29.5	241.2	29.6	242.2	29.7	243.2	29.9	244.2	30.0	83
8	237.7	33.4	238.7	33.5	239.6	33.7	240.6	33.8	241.6	34.0	242.6	34.1	243.6	34.2	82
9	237.0	37.5	238.0	37.7	239.0	37.9	240.0	38.0	241.0	38.2	242.0	38.3	243.0	38.5	81
10	236.4	41.7	237.3	41.8	238.3	42.0	239.3	42.2	240.3	42.4	241.3	42.5	242.3	42.7	80
11	235.6	45.8	236.6	46.0	237.6	46.2	238.5	46.4	239.5	46.6	240.5	46.7	241.5	46.9	79
12	234.8	49.9	235.7	50.1	236.7	50.3	237.7	50.5	238.7	50.7	239.6	50.9	240.6	51.1	78
13	233.8	54.0	234.8	54.2	235.8	54.4	236.8	54.7	237.7	54.9	238.7	55.1	239.7	55.3	77
14	232.9	58.1	233.8	58.3	234.8	58.5	235.8	58.8	236.8	59.0	237.7	59.3	238.7	59.5	76
15	231.8	62.1	232.8	62.4	233.8	62.6	234.7	62.9	235.7	63.2	236.7	63.4	237.6	63.7	75
16	230.7	66.2	231.7	66.4	232.6	66.7	233.6	67.0	234.5	67.3	235.5	67.5	236.5	67.8	74
17	229.5	70.2	230.5	70.5	231.4	70.8	232.4	71.0	233.3	71.3	234.3	71.6	235.3	71.9	73
18	228.3	74.2	229.2	74.5	230.2	74.8	231.1	75.1	232.1	75.4	233.0	75.7	234.0	76.0	72
19	226.9	78.1	227.9	78.5	228.8	78.8	229.8	79.1	230.7	79.4	231.7	79.8	232.6	80.1	71
20	225.5	82.1	226.5	82.4	227.4	82.8	228.3	83.1	229.3	83.5	230.2	83.8	231.2	84.1	70
21	224.1	86.0	225.0	86.4	225.9	86.7	226.9	87.1	227.8	87.4	228.7	87.8	229.7	88.2	69
22	222.5	89.9	223.5	90.3	224.4	90.7	225.3	91.0	226.2	91.4	227.2	91.8	228.1	92.2	68
23	220.9	93.8	221.8	94.2	222.8	94.6	223.7	94.9	224.6	95.3	225.5	95.7	226.4	96.1	67
24	219.3	97.6	220.2	98.0	221.1	98.4	222.0	98.8	222.9	99.2	223.8	99.7	224.7	100.1	66
25	217.5	101.4	218.4	101.9	219.3	102.3	220.2	102.7	221.1	103.1	222.0	103.5	223.0	104.0	65
26	215.7	105.2	216.6	105.6	217.5	106.1	218.4	106.5	219.3	107.0	220.2	107.4	221.1	107.8	64
27	213.8	109.0	214.7	109.4	215.6	109.9	216.5	110.3	217.4	110.8	218.3	111.2	219.2	111.7	63
28	211.9	112.7	212.8	113.1	213.7	113.6	214.6	114.1	215.4	114.6	216.3	115.0	217.2	115.5	62
29	209.9	116.4	210.8	116.8	211.7	117.3	212.5	117.8	213.4	118.3	214.3	118.8	215.2	119.3	61
30	207.8	120.0	208.7	120.5	209.6	121.0	210.4	121.5	211.3	122.0	212.2	122.5	213.0	123.0	60
31	205.7	123.6	206.6	124.1	207.4	124.6	208.3	125.2	209.1	125.7	210.0	126.2	210.9	126.7	59
32	203.5	127.2	204.4	127.7	205.2	128.2	206.1	128.8	206.9	129.3	207.8	129.8	208.6	130.4	58
33	201.3	130.7	202.1	131.3	203.0	131.8	203.8	132.3	204.6	132.9	205.5	133.4	206.3	134.0	57
34	199.0	134.2	199.8	134.8	200.6	135.3	201.5	135.9	202.3	136.4	203.1	137.0	203.9	137.6	56
35	196.6	137.7	197.4	138.2	198.2	138.8	199.1	139.4	199.9	140.0	200.7	140.5	201.5	141.1	55
36	194.2	141.1	195.0	141.7	195.8	142.2	196.6	142.8	197.4	143.4	198.2	144.0	199.0	144.6	54
37	191.7	144.4	192.5	145.0	193.3	145.6	194.1	146.2	194.9	146.8	195.7	147.4	196.5	148.0	53
38	189.1	147.8	189.9	148.4	190.7	149.0	191.5	149.6	192.3	150.2	193.1	150.8	193.9	151.5	52
39	186.5	151.0	187.3	151.7	188.1	152.3	188.8	152.9	189.6	153.6	190.4	154.2	191.2	154.8	51
40	183.9	154.3	184.6	154.9	185.4	155.6	186.1	156.2	186.9	156.8	187.7	157.5	188.4	158.1	50
41	181.1	157.5	181.9	158.1	182.6	158.8	183.4	159.4	184.1	160.1	184.9	160.7	185.7	161.4	49
42	178.4	160.6	179.1	161.3	179.8	161.9	180.6	162.6	181.3	163.3	182.1	163.9	182.8	164.6	48
43	175.5	163.7	176.3	164.4	177.0	165.0	177.7	165.7	178.5	166.4	179.2	167.1	179.9	167.8	47
44	172.6	166.7	173.4	167.4	174.1	168.1	174.8	168.8	175.5	169.5	176.2	170.2	177.0	170.9	46
45	169.7	169.7	170.4	170.4	171.1	171.1	171.8	171.8	172.5	172.5	173.2	173.2	173.9	173.9	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	D=240′		D=241′		D=242′		D=243′		D=244′		D=245′		D=246′		

Plane Traverse Table

Course.	D=247′		D=248′		D=249′		D=250′		D=251′		D=252′		D=253′		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	247.0	0.0	248.0	0.0	249.0	0.0	250.0	0.0	251.0	0.0	252.0	0.0	253.0	0.0	90
1	247.0	4.3	248.0	4.3	249.0	4.3	250.0	4.4	251.0	4.4	252.0	4.4	253.0	4.4	89
2	246.8	8.6	247.8	8.7	248.8	8.7	249.8	8.7	250.8	8.8	251.8	8.8	252.8	8.8	88
3	246.7	12.9	247.7	13.0	248.7	13.0	249.7	13.1	250.7	13.1	251.7	13.2	252.7	13.2	87
4	246.4	17.2	247.4	17.3	248.4	17.4	249.4	17.4	250.4	17.5	251.4	17.6	252.4	17.6	86
5	246.1	21.5	247.1	21.6	248.1	21.7	249.0	21.8	250.0	21.9	251.0	22.0	252.0	22.1	85
6	245.6	25.8	246.6	25.9	247.6	26.0	248.6	26.1	249.6	26.2	250.6	26.3	251.6	26.4	84
7	245.2	30.1	246.2	30.2	247.1	30.3	248.1	30.5	249.1	30.6	250.1	30.7	251.1	30.8	83
8	244.6	34.4	245.6	34.5	246.6	34.7	247.6	34.8	248.6	34.9	249.5	35.1	250.5	35.2	82
9	244.0	38.6	244.9	38.8	245.9	39.0	246.9	39.1	247.9	39.3	248.9	39.4	249.9	39.6	81
10	243.2	42.9	244.2	43.1	245.2	43.2	246.2	43.4	247.2	43.6	248.2	43.8	249.2	43.9	80
11	242.5	47.1	243.4	47.3	244.4	47.5	245.4	47.7	246.4	47.9	247.4	48.1	248.4	48.3	79
12	241.6	51.4	242.6	51.6	243.6	51.8	244.5	52.0	245.5	52.2	246.5	52.4	247.5	52.6	78
13	240.7	55.6	241.6	55.8	242.6	56.0	243.6	56.2	244.6	56.5	245.5	56.7	246.5	56.9	77
14	239.7	59.8	240.6	60.0	241.6	60.2	242.6	60.5	243.5	60.7	244.5	61.0	245.5	61.2	76
15	238.6	63.9	239.5	64.2	240.5	64.4	241.5	64.7	242.4	65.0	243.4	65.2	244.4	65.5	75
16	237.4	68.1	238.4	68.4	239.4	68.6	240.3	68.9	241.3	69.2	242.2	69.5	243.2	69.7	74
17	236.2	72.2	237.2	72.5	238.1	72.8	239.1	73.1	240.0	73.4	241.0	73.7	241.9	74.0	73
18	234.9	76.3	235.9	76.6	236.8	76.9	237.8	77.3	238.7	77.6	239.7	77.9	240.6	78.2	72
19	233.5	80.4	234.5	80.7	235.4	81.1	236.4	81.4	237.3	81.7	238.3	82.0	239.2	82.4	71
20	232.1	84.5	233.0	84.8	234.0	85.2	234.9	85.5	235.9	85.8	236.8	86.2	237.7	86.5	70
21	230.6	88.5	231.5	88.9	232.5	89.2	233.4	89.6	234.3	90.0	235.3	90.3	236.2	90.7	69
22	229.0	92.5	229.9	92.9	230.9	93.3	231.8	93.7	232.7	94.0	233.7	94.4	234.6	94.8	68
23	227.4	96.5	228.3	96.9	229.2	97.3	230.1	97.7	231.0	98.1	232.0	98.5	232.9	98.9	67
24	225.6	100.5	226.6	100.9	227.5	101.3	228.4	101.7	229.3	102.1	230.2	102.5	231.1	102.9	66
25	223.9	104.4	224.8	104.8	225.7	105.2	226.6	105.7	227.5	106.1	228.4	106.5	229.3	106.9	65
26	222.0	108.3	222.9	108.7	223.8	109.2	224.7	109.6	225.6	110.0	226.5	110.5	227.4	110.9	64
27	220.1	112.1	221.0	112.6	221.9	113.0	222.8	113.5	223.6	114.0	224.5	114.4	225.4	114.9	63
28	218.1	116.0	219.0	116.4	219.9	116.9	220.7	117.4	221.6	117.8	222.5	118.3	223.4	118.8	62
29	216.0	119.7	216.9	120.2	217.8	120.7	218.7	121.2	219.5	121.7	220.4	122.2	221.3	122.7	61
30	213.9	123.5	214.8	124.0	215.6	124.5	216.5	125.0	217.4	125.5	218.2	126.0	219.1	126.5	60
31	211.7	127.2	212.6	127.7	213.4	128.2	214.3	128.8	215.1	129.3	216.0	129.8	216.9	130.3	59
32	209.5	130.9	210.3	131.4	211.2	131.9	212.0	132.5	212.9	133.0	213.7	133.5	214.6	134.1	58
33	207.2	134.5	208.0	135.1	208.8	135.6	209.7	136.2	210.5	136.7	211.3	137.2	212.2	137.8	57
34	204.8	138.1	205.6	138.7	206.4	139.2	207.3	139.8	208.1	140.4	208.9	140.9	209.7	141.5	56
35	202.3	141.7	203.1	142.2	204.0	142.8	204.8	143.4	205.6	144.0	206.4	144.5	207.2	145.1	55
36	199.8	145.2	200.6	145.8	201.4	146.4	202.3	146.9	203.1	147.5	203.9	148.1	204.7	148.7	54
37	197.3	148.6	198.1	149.3	198.9	149.9	199.7	150.5	200.5	151.1	201.3	151.7	202.1	152.3	53
38	194.6	152.1	195.4	152.7	196.2	153.3	197.0	153.9	197.8	154.5	198.6	155.1	199.4	155.8	52
39	192.0	155.4	192.7	156.1	193.5	156.7	194.3	157.3	195.1	158.0	195.8	158.6	196.6	159.2	51
40	189.2	158.8	190.0	159.4	190.7	160.1	191.5	160.7	192.3	161.3	193.0	162.0	193.8	162.6	50
41	186.4	162.0	187.2	162.7	187.9	163.4	188.7	164.0	189.4	164.7	190.2	165.3	190.9	166.0	49
42	183.6	165.3	184.3	165.9	185.0	166.6	185.8	167.3	186.5	168.0	187.3	168.6	188.0	169.3	48
43	180.6	168.5	181.4	169.1	182.1	169.8	182.8	170.5	183.6	171.2	184.3	171.9	185.0	172.5	47
44	177.7	171.6	178.4	172.3	179.1	173.0	179.8	173.7	180.6	174.4	181.3	175.1	182.0	175.7	46
45	174.7	174.7	175.4	175.4	176.1	176.1	176.8	176.8	177.5	177.5	178.2	178.2	178.9	178.9	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	D=247′		D=248′		D=249′		D=250′		D=251′		D=252′		D=253′		

Plane Traverse Table

Course.	D=254′		D=255′		D=256′		D=257′		D=258′		D=259′		D=260′		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	254.0	0.0	255.0	0.0	256.0	0.0	257.0	0.0	258.0	0.0	259.0	0.0	260.0	0.0	90
1	254.0	4.4	255.0	4.5	256.0	4.5	257.0	4.5	258.0	4.5	259.0	4.5	260.0	4.5	89
2	253.8	8.9	254.8	8.9	255.8	8.9	256.8	9.0	257.8	9.0	258.8	9.0	259.8	9.1	88
3	253.7	13.3	254.7	13.3	255.6	13.4	256.6	13.5	257.6	13.5	258.6	13.6	259.6	13.6	87
4	253.4	17.7	254.4	17.8	255.4	17.9	256.4	17.9	257.4	18.0	258.4	18.1	259.4	18.1	86
5	253.0	22.1	254.0	22.2	255.0	22.3	256.0	22.4	257.0	22.5	258.0	22.6	259.0	22.7	85
6	252.6	26.6	253.6	26.7	254.6	26.8	255.6	26.9	256.6	27.0	257.6	27.1	258.6	27.2	84
7	252.1	31.0	253.1	31.1	254.1	31.2	255.1	31.3	256.1	31.4	257.1	31.6	258.1	31.7	83
8	251.5	35.3	252.5	35.5	253.5	35.6	254.5	35.8	255.5	35.9	256.5	36.0	257.5	36.2	82
9	250.9	39.7	251.9	39.9	252.8	40.0	253.8	40.2	254.8	40.4	255.8	40.5	256.8	40.7	81
10	250.1	44.1	251.1	44.3	252.1	44.5	253.1	44.6	254.1	44.8	255.1	45.0	256.1	45.1	80
11	249.3	48.5	250.3	48.7	251.3	48.8	252.3	49.0	253.3	49.2	254.2	49.4	255.2	49.6	79
12	248.4	52.8	249.4	53.0	250.4	53.2	251.4	53.4	252.4	53.6	253.3	53.8	254.3	54.1	78
13	247.5	57.1	248.5	57.4	249.4	57.6	250.4	57.8	251.4	58.0	252.4	58.3	253.3	58.5	77
14	246.5	61.4	247.4	61.7	248.4	61.9	249.4	62.2	250.3	62.4	251.3	62.7	252.3	62.9	76
15	245.3	65.7	246.3	66.0	247.3	66.3	248.2	66.5	249.2	66.8	250.2	67.0	251.1	67.3	75
16	244.2	70.0	245.1	70.3	246.1	70.6	247.0	70.8	248.0	71.1	249.0	71.4	249.9	71.7	74
17	242.9	74.3	243.9	74.6	244.8	74.8	245.8	75.1	246.7	75.4	247.7	75.7	248.6	76.0	73
18	241.6	78.5	242.5	78.8	243.5	79.1	244.4	79.4	245.4	79.7	246.3	80.0	247.3	80.3	72
19	240.2	82.7	241.1	83.0	242.1	83.3	243.0	83.7	243.9	84.0	244.9	84.3	245.8	84.6	71
20	238.7	86.9	239.6	87.2	240.6	87.6	241.5	87.9	242.4	88.2	243.4	88.6	244.3	88.9	70
21	237.1	91.0	238.1	91.4	239.0	91.7	239.9	92.1	240.9	92.5	241.8	92.8	242.7	93.2	69
22	235.5	95.2	236.4	95.5	237.4	95.9	238.3	96.3	239.2	96.6	240.1	97.0	241.1	97.4	68
23	233.8	99.2	234.7	99.6	235.6	100.0	236.6	100.4	237.5	100.8	238.4	101.2	239.3	101.6	67
24	232.0	103.3	233.0	103.7	233.9	104.1	234.8	104.5	235.7	104.9	236.6	105.3	237.5	105.8	66
25	230.2	107.3	231.1	107.8	232.0	108.2	232.9	108.6	233.8	109.0	234.7	109.5	235.6	109.9	65
26	228.3	111.3	229.2	111.8	230.1	112.2	231.0	112.7	231.9	113.1	232.8	113.5	233.7	114.0	64
27	226.3	115.3	227.2	115.8	228.1	116.2	229.0	116.7	229.9	117.1	230.8	117.6	231.7	118.0	63
28	224.3	119.2	225.2	119.7	226.0	120.2	226.9	120.7	227.8	121.1	228.7	121.6	229.6	122.1	62
29	222.2	123.1	223.0	123.6	223.9	124.1	224.8	124.6	225.7	125.1	226.5	125.6	227.4	126.1	61
30	220.0	127.0	220.8	127.5	221.7	128.0	222.6	128.5	223.4	129.0	224.3	129.5	225.2	130.0	60
31	217.7	130.8	218.6	131.3	219.4	131.8	220.3	132.4	221.1	132.9	222.0	133.4	222.9	133.9	59
32	215.4	134.6	216.3	135.1	217.1	135.7	217.9	136.2	218.8	136.7	219.6	137.2	220.5	137.8	58
33	213.0	138.3	213.9	138.9	214.7	139.4	215.5	140.0	216.4	140.5	217.2	141.1	218.1	141.6	57
34	210.6	142.0	211.4	142.6	212.2	143.2	213.1	143.7	213.9	144.3	214.7	144.8	215.5	145.4	56
35	208.1	145.7	208.9	146.3	209.7	146.8	210.5	147.4	211.3	148.0	212.2	148.6	213.0	149.1	55
36	205.5	149.3	206.3	149.9	207.1	150.5	207.9	151.1	208.7	151.6	209.5	152.2	210.3	152.8	54
37	202.9	152.9	203.7	153.5	204.5	154.1	205.2	154.7	206.0	155.3	206.8	155.9	207.6	156.5	53
38	200.2	156.4	200.9	157.0	201.7	157.6	202.5	158.2	203.3	158.8	204.1	159.5	204.9	160.1	52
39	197.4	159.8	198.2	160.5	198.9	161.1	199.7	161.7	200.5	162.4	201.3	163.0	202.1	163.6	51
40	194.6	163.3	195.3	163.9	196.1	164.6	196.9	165.2	197.6	165.8	198.4	166.5	199.2	167.1	50
41	191.7	166.6	192.5	167.3	193.2	168.0	194.0	168.6	194.7	169.3	195.5	169.9	196.2	170.6	49
42	188.8	170.0	189.5	170.6	190.2	171.3	191.0	172.0	191.7	172.6	192.5	173.3	193.2	174.0	48
43	185.8	173.2	186.5	173.9	187.2	174.6	188.0	175.3	188.7	176.0	189.4	176.6	190.2	177.3	47
44	182.7	176.4	183.4	177.1	184.2	177.8	184.9	178.5	185.6	179.2	186.3	179.9	187.0	180.6	46
45	179.6	179.6	180.3	180.3	181.0	181.0	181.7	181.7	182.4	182.4	183.1	183.1	183.8	183.8	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	D=254′		D=255′		D=256′		D=257′		D=258′		D=259′		D=260′		

Plane Traverse Table

Course.	D=261′		D=262′		D=263′		D=264′		D=265′		D=266′		D=267′		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	261.0	0.0	262.0	0.0	263.0	0.0	264.0	0.0	265.0	0.0	266.0	0.0	267.0	0.0	90
1	261.0	4.6	262.0	4.6	263.0	4.6	264.0	4.6	265.0	4.6	266.0	4.6	267.0	4.7	89
2	260.8	9.1	261.8	9.1	262.8	9.2	263.8	9.2	264.8	9.2	265.8	9.3	266.8	9.3	88
3	260.6	13.7	261.6	13.7	262.6	13.8	263.6	13.8	264.6	13.9	265.6	13.9	266.6	14.0	87
4	260.4	18.2	261.4	18.3	262.4	18.3	263.4	18.4	264.4	18.5	265.4	18.6	266.3	18.6	86
5	260.0	22.7	261.0	22.8	262.0	22.9	263.0	23.0	264.0	23.1	265.0	23.2	266.0	23.3	85
6	259.6	27.3	260.6	27.4	261.6	27.5	262.6	27.6	263.5	27.7	264.5	27.8	265.5	27.9	84
7	259.1	31.8	260.0	31.9	261.0	32.1	262.0	32.2	263.0	32.3	264.0	32.4	265.0	32.5	83
8	258.5	36.3	259.5	36.5	260.4	36.6	261.4	36.7	262.4	36.9	263.4	37.0	264.4	37.2	82
9	257.8	40.8	258.8	41.0	259.8	41.1	260.7	41.3	261.7	41.5	262.7	41.6	263.7	41.8	81
10	257.0	45.3	258.0	45.5	259.0	45.7	260.0	45.8	261.0	46.0	262.0	46.2	262.9	46.4	80
11	256.2	49.8	257.2	50.0	258.2	50.2	259.1	50.4	260.1	50.6	261.1	50.8	262.1	50.9	79
12	255.3	54.3	256.3	54.5	257.3	54.7	258.2	54.9	259.2	55.1	260.2	55.3	261.2	55.5	78
13	254.3	58.7	255.3	58.9	256.3	59.2	257.2	59.4	258.2	59.6	259.2	59.8	260.2	60.1	77
14	253.2	63.1	254.2	63.4	255.2	63.6	256.2	63.9	257.1	64.1	258.1	64.4	259.1	64.6	76
15	252.1	67.6	253.1	67.8	254.0	68.1	255.0	68.3	256.0	68.6	256.9	68.8	257.9	69.1	75
16	250.9	71.9	251.9	72.2	252.8	72.5	253.8	72.8	254.7	73.0	255.7	73.3	256.7	73.6	74
17	249.6	76.3	250.6	76.6	251.5	76.9	252.5	77.2	253.4	77.5	254.4	77.8	255.3	78.1	73
18	248.2	80.7	249.2	81.0	250.1	81.3	251.1	81.6	252.0	81.9	253.0	82.2	253.9	82.5	72
19	246.8	85.0	247.7	85.3	248.7	85.6	249.6	86.0	250.6	86.3	251.5	86.6	252.5	86.9	71
20	245.3	89.3	246.2	89.6	247.1	90.0	248.1	90.3	249.0	90.6	250.0	91.0	250.9	91.3	70
21	243.7	93.5	244.6	93.9	245.5	94.3	246.5	94.6	247.4	95.0	248.3	95.3	249.3	95.7	69
22	242.0	97.8	242.9	98.1	243.8	98.5	244.8	98.9	245.7	99.3	246.6	99.6	247.6	100.0	68
23	240.3	102.0	241.2	102.4	242.1	102.8	243.0	103.2	243.9	103.5	244.9	103.9	245.8	104.3	67
24	238.4	106.2	239.3	106.6	240.3	107.0	241.2	107.4	242.1	107.8	243.0	108.2	243.9	108.6	66
25	236.5	110.3	237.5	110.7	238.4	111.1	239.3	111.6	240.2	112.0	241.1	112.4	242.0	112.8	65
26	234.6	114.4	235.5	114.9	236.4	115.3	237.3	115.7	238.2	116.2	239.1	116.6	240.0	117.0	64
27	232.6	118.5	233.4	118.9	234.3	119.4	235.2	119.9	236.1	120.3	237.0	120.8	237.9	121.2	63
28	230.4	122.5	231.3	123.0	232.2	123.5	233.1	123.9	234.0	124.4	234.9	124.9	235.7	125.3	62
29	228.3	126.5	229.2	127.0	230.0	127.5	230.9	128.0	231.8	128.5	232.6	129.0	233.5	129.4	61
30	226.0	130.5	226.9	131.0	227.8	131.5	228.6	132.0	229.5	132.5	230.4	133.0	231.2	133.5	60
31	223.7	134.4	224.6	134.9	225.4	135.5	226.3	136.0	227.1	136.5	228.0	137.0	228.9	137.5	59
32	221.3	138.3	222.2	138.8	223.0	139.4	223.9	139.9	224.7	140.4	225.6	141.0	226.4	141.5	58
33	218.9	142.2	219.7	142.7	220.6	143.2	221.4	143.8	222.2	144.3	223.1	144.9	223.9	145.4	57
34	216.4	145.9	217.2	146.5	218.0	147.1	218.9	147.6	219.7	148.2	220.5	148.7	221.4	149.3	56
35	213.8	149.7	214.6	150.3	215.4	150.9	216.3	151.4	217.1	152.0	217.9	152.6	218.7	153.1	55
36	211.2	153.4	212.0	154.0	212.8	154.6	213.6	155.2	214.4	155.8	215.2	156.4	216.0	156.9	54
37	208.4	157.1	209.2	157.7	210.0	158.3	210.8	158.9	211.6	159.5	212.4	160.1	213.2	160.7	53
38	205.7	160.7	206.5	161.3	207.2	161.9	208.0	162.5	208.8	163.2	209.6	163.8	210.4	164.4	52
39	202.8	164.3	203.6	164.9	204.4	165.5	205.2	166.1	205.9	166.8	206.7	167.4	207.5	168.0	51
40	199.9	167.8	200.7	168.4	201.5	169.1	202.2	169.7	203.0	170.3	203.8	171.0	204.5	171.6	50
41	197.0	171.2	197.7	171.9	198.5	172.5	199.2	173.2	200.0	173.9	200.8	174.5	201.5	175.2	49
42	194.0	174.6	194.7	175.3	195.4	176.0	196.2	176.7	196.9	177.3	197.7	178.0	198.4	178.7	48
43	190.9	178.0	191.6	178.7	192.3	179.4	193.1	180.0	193.8	180.7	194.5	181.4	195.3	182.1	47
44	187.7	181.3	188.5	182.0	189.2	182.7	189.9	183.4	190.6	184.1	191.3	184.8	192.1	185.5	46
45	184.6	184.6	185.3	185.3	186.0	186.0	186.7	186.7	187.4	187.4	188.1	188.1	188.8	188.8	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	D=261′		D=262′		D=263′		D=264′		D=265′		D=266′		D=267′		

Plane Traverse Table

Course.	D=268′		D=269′		D=270′		D=271′		D=272′		D=273′		D=274′		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	268.0	0.0	269.0	0.0	270.0	0.0	271.0	0.0	272.0	0.0	273.0	0.0	274.0	0.0	90
1	268.0	4.7	269.0	4.7	270.0	4.7	271.0	4.7	272.0	4.7	273.0	4.8	274.0	4.8	89
2	267.8	9.4	268.8	9.4	269.8	9.4	270.8	9.5	271.8	9.5	272.8	9.5	273.8	9.6	88
3	267.6	14.0	268.6	14.1	269.6	14.1	270.6	14.2	271.6	14.2	272.6	14.3	273.6	14.3	87
4	267.3	18.7	268.3	18.8	269.3	18.8	270.3	18.9	271.3	19.0	272.3	19.0	273.3	19.1	86
5	267.0	23.4	268.0	23.4	269.0	23.5	270.0	23.6	271.0	23.7	272.0	23.8	273.0	23.9	85
6	266.5	28.0	267.5	28.1	268.5	28.2	269.5	28.3	270.5	28.4	271.5	28.5	272.5	28.6	84
7	266.0	32.7	267.0	32.8	268.0	32.9	269.0	33.0	270.0	33.1	271.0	33.3	272.0	33.4	83
8	265.4	37.3	266.4	37.4	267.4	37.6	268.4	37.7	269.4	37.9	270.3	38.0	271.3	38.1	82
9	264.7	41.9	265.7	42.1	266.7	42.2	267.7	42.4	268.7	42.6	269.6	42.7	270.6	42.9	81
10	263.9	46.5	264.9	46.7	265.9	46.9	266.9	47.1	267.9	47.2	268.9	47.4	269.8	47.6	80
11	263.1	51.1	264.1	51.3	265.0	51.5	266.0	51.7	267.0	51.9	268.0	52.1	269.0	52.3	79
12	262.1	55.7	263.1	55.9	264.1	56.1	265.1	56.3	266.1	56.6	267.0	56.8	268.0	57.0	78
13	261.1	60.3	262.1	60.5	263.1	60.7	264.1	61.0	265.0	61.2	266.0	61.4	267.0	61.6	77
14	260.0	64.8	261.0	65.1	262.0	65.3	263.0	65.6	263.9	65.8	264.9	66.0	265.9	66.3	76
15	258.9	69.4	259.8	69.6	260.8	69.9	261.8	70.1	262.7	70.4	263.7	70.7	264.7	70.9	75
16	257.6	73.9	258.6	74.1	259.5	74.4	260.5	74.7	261.5	75.0	262.4	75.2	263.4	75.5	74
17	256.3	78.4	257.2	78.6	258.2	78.9	259.2	79.2	260.1	79.5	261.1	79.8	262.0	80.1	73
18	254.9	82.8	255.8	83.1	256.8	83.4	257.7	83.7	258.7	84.1	259.6	84.4	260.6	84.7	72
19	253.4	87.3	254.3	87.6	255.3	87.9	256.2	88.2	257.2	88.6	258.1	88.9	259.1	89.2	71
20	251.8	91.7	252.8	92.0	253.7	92.3	254.7	92.7	255.6	93.0	256.5	93.4	257.5	93.7	70
21	250.2	96.0	251.1	96.4	252.1	96.8	253.0	97.1	253.9	97.5	254.9	97.8	255.8	98.2	69
22	248.5	100.4	249.4	100.8	250.3	101.1	251.3	101.5	252.2	101.9	253.1	102.3	254.0	102.6	68
23	246.7	104.7	247.6	105.1	248.5	105.5	249.5	105.9	250.4	106.3	251.3	106.7	252.2	107.1	67
24	244.8	109.0	245.7	109.4	246.7	109.8	247.6	110.2	248.5	110.6	249 4	111.0	250.3	111.4	66
25	242.9	113.3	243.8	113.7	244.7	114.1	245.6	114.5	246.5	115.0	247.4	115.4	248.3	115.8	65
26	240.9	117.5	241.8	117.9	242.7	118.4	243.6	118.8	244.5	119.2	245.4	119.7	246.3	120.1	64
27	238.8	121.7	239.7	122.1	240.6	122.6	241.5	123.0	242.4	123.5	243.2	123.9	244.1	124.4	63
28	236.6	125.8	237.5	126.3	238.4	126.8	239.3	127.2	240.2	127.7	241.0	128.2	241.9	128.6	62
29	234.4	129.9	235.3	130.4	236.1	130.9	237.0	131.4	237.9	131.9	238.8	132.4	239.6	132.8	61
30	232.1	134.0	233.0	134.5	233.8	135.0	234.7	135.5	235.6	136.0	236.4	136.5	237.3	137.0	60
31	229.7	138.0	230.6	138.5	231.4	139.1	232.3	139.6	233.1	140.1	234.0	140.6	234.9	141.1	59
32	227.3	142.0	228.1	142.5	229.0	143.1	229.8	143.6	230.7	144.1	231.5	144.7	232.4	145.2	58
33	224.8	146.0	225.6	146.5	226.4	147.1	227.3	147.6	228.1	148.1	229.0	148.7	229.8	149.2	57
34	222.2	149.9	223.0	150.4	223.8	151.0	224.7	151.5	225.5	152.1	226.3	152.7	227.2	153.2	56
35	219.5	153.7	220.4	154.3	221.2	154.9	222.0	155.4	222.8	156.0	223.6	156.6	224.4	157.2	55
36	216.8	157.5	217.6	158.1	218.4	158.7	219.2	159.3	220.1	159.9	220.9	160.5	221.7	161.1	54
37	214.0	161.3	214.8	161.9	215.6	162.5	216.4	163.1	217.2	163.7	218.0	164.3	218.8	164.9	53
38	211.2	165.0	212.0	165.6	212.8	166.2	213.6	166.8	214.3	167.5	215.1	168.1	215.9	168.7	52
39	208.3	168.7	209.1	169.3	209.8	169.9	210.6	170.5	211.4	171.2	212.2	171.8	212.9	172.4	51
40	205.3	172.3	206.1	172.9	2c6.8	173.6	207.6	174.2	208.4	174.8	209.1	175.5	209.9	176.1	50
41	202.3	175.8	203.0	176.5	203.8	177.1	204.5	177.8	205.3	178.4	206.0	179.1	206.8	179.8	49
42	199.2	179.3	199.9	180.0	200.6	180.7	201.4	181.3	202.1	182.0	202.9	182.7	203.6	183.3	48
43	196.0	182.8	196.7	183.5	197.5	184.1	198.2	184.8	198.9	185.5	199.7	186.2	200.4	186.9	47
44	192.8	186.2	193.5	186.9	194.2	187.6	194.9	188.3	195.7	188.9	196.4	189.6	197.1	190.3	46
45	189.5	189.5	190.2	190.2	190.9	190.9	191.6	191.6	192.3	192.3	193.0	193.0	193.7	193.7	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	D=268′		D=269′		D=270′		D=271′		D=272′		D=273′		D=274′		

Plane Traverse Table

Course.	D=275′		D=276′		D=277′		D=278′		D=279′		D=280′		D=281′		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	275.0	0.0	276.0	0.0	277.0	0.0	278.0	0.0	279.0	0.0	280.0	0.0	281.0	0.0	90
1	275.0	4.8	276.0	4.8	277.0	4.8	278.0	4.9	279.0	4.9	280.0	4.9	281.0	4.9	89
2	274.8	9.6	275.8	9.6	276.8	9.7	277.8	9.7	278.8	9.7	279.8	9.8	280.8	9.8	88
3	274.6	14.4	275.6	14.4	276.6	14.5	277.6	14.5	278.6	14.6	279.6	14.7	280.6	14.7	87
4	274.3	19.2	275.3	19.3	276.3	19.3	277.3	19.4	278.3	19.5	279.3	19.5	280.3	19.6	86
5	274.0	24.0	274.9	24.1	275.9	24.1	276.9	24.2	277.9	24.3	278.9	24.4	279.9	24.5	85
6	273.5	28.7	274.5	28.8	275.5	29.0	276.5	29.1	277.5	29.2	278.5	29.3	279.5	29.4	84
7	273.0	33.5	273.9	33.6	274.9	33.8	275.9	33.9	276.9	34.0	277.9	34.1	278.9	34.2	83
8	272.3	38.3	273.3	38.4	274.3	38.6	275.3	38.7	276.3	38.8	277.3	39.0	278.3	39.1	82
9	271.6	43.0	272.6	43.2	273.6	43.3	274.6	43.5	275.6	43.6	276.6	43.8	277.5	44.0	81
10	270.8	47.8	271.8	47.9	272.8	48.1	273.8	48.3	274.8	48.4	275.7	48.6	276.7	48.8	80
11	269.9	52.5	270.9	52.7	271.9	52.9	272.9	53.0	273.9	53.2	274.9	53.4	275.8	53.6	79
12	269.0	57.2	270.0	57.4	270.9	57.6	271.9	57.8	272.9	58.0	273.9	58.2	274.9	58.4	78
13	268.0	61.9	268.9	62.1	269.9	62.3	270.9	62.5	271.8	62.8	272.8	63.0	273.8	63.2	77
14	266.8	66.5	267.8	66.8	268.8	67.0	269.7	67.3	270.7	67.5	271.7	67.7	272.7	68.0	76
15	265.6	71.2	266.6	71.4	267.6	71.7	268.5	72.0	269.5	72.2	270.5	72.5	271.4	72.7	75
16	264.3	75.8	265.3	76.1	266.3	76.4	267.2	76.6	268.2	76.9	269.2	77.2	270.1	77.5	74
17	263.0	80.4	263.9	80.7	264.9	81.0	265.9	81.3	266.8	81.6	267.8	81.9	268.7	82.2	73
18	261.5	85.0	262.5	85.3	263.4	85.6	264.4	85.9	265.3	86.2	266.3	86.5	267.2	86.8	72
19	260.0	89.5	261.0	89.9	261.9	90.2	262.9	90.5	263.8	90.8	264.7	91.2	265.7	91.5	71
20	258.4	94.1	259.4	94.4	260.3	94.7	261.2	95.1	262.2	95.4	263.1	95.8	264.1	96.1	70
21	256.7	98.6	257.7	98.9	258.6	99.3	259.5	99.6	260.5	100.0	261.4	100.3	262.3	100.7	69
22	255.0	103.0	255.9	103.4	256.8	103.8	257.8	104.1	258.7	104.5	259.6	104.9	260.5	105.3	68
23	253.1	107.5	254.1	107.8	255.0	108.2	255.9	108.6	256.8	109.0	257.7	109.4	258.7	109.8	67
24	251.2	111.9	252.1	112.3	253.1	112.7	254.0	113.1	254.9	113.5	255.8	113.9	256.7	114.3	66
25	249.2	116.2	250.1	116.6	251.0	117.1	252.0	117.5	252.9	117.9	253.8	118.3	254.7	118.8	65
26	247.2	120.6	248.1	121.0	249.0	121.4	249.9	121.9	250.8	122.3	251.7	122.7	252.6	123.2	64
27	245.0	124.8	245.9	125.3	246.8	125.8	247.7	126.2	248.6	126.7	249.5	127.1	250.4	127.6	63
28	242.8	129.1	243.7	129.6	244.6	130.0	245.5	130.5	246.3	131.0	247.2	131.5	248.1	131.9	62
29	240.5	133.3	241.4	133.8	242.3	134.3	243.1	134.8	244.0	135.3	244.9	135.7	245.8	136.2	61
30	238.2	137.5	239.0	138.0	239.9	138.5	240.8	139.0	241.6	139.5	242.5	140.0	243.4	140.5	60
31	235.7	141.6	236.6	142.2	237.4	142.7	238.3	143.2	239.1	143.7	240.0	144.2	240.9	144.7	59
32	233.2	145.7	234.1	146.3	234.9	146.8	235.8	147.3	236.6	147.8	237.5	148.4	238.3	148.9	58
33	230.6	149.8	231.5	150.3	232.3	150.9	233.2	151.4	234.0	152.0	234.8	152.5	235.7	153.0	57
34	228.0	153.8	228.8	154.3	229.6	154.9	230.5	155.5	231.3	156.0	232.1	156.6	233.0	157.1	56
35	225.3	157.7	226.1	158.3	226.9	158.9	227.7	159.5	228.5	160.0	229.4	160.6	230.2	161.2	55
36	222.5	161.6	223.3	162.2	224.1	162.8	224.9	163.4	225.7	164.0	226.5	164.6	227.3	165.2	54
37	219.6	165.5	220.4	166.1	221.2	166.7	222.0	167.3	222.8	167.9	223.6	168.5	224.4	169.1	53
38	216.7	169.3	217.5	169.9	218.3	170.5	219.1	171.2	219.9	171.8	220.6	172.4	221.4	173.0	52
39	213.7	173.1	214.5	173.7	215.3	174.3	216.0	175.0	216.8	175.6	217.6	176.2	218.4	176.8	51
40	210.7	176.8	211.4	177.4	212.2	178.1	213.0	178.7	213.7	179.3	214.5	180.0	215.3	180.6	50
41	207.5	180.4	208.3	181.1	209.1	181.7	209.8	182.4	210.6	183.0	211.3	183.7	212.1	184.4	49
42	204.4	184.0	205.1	184.7	205.9	185.3	206.6	186.0	207.3	186.7	208.1	187.4	208.8	188.0	48
43	201.1	187.5	201.9	188.2	202.6	188.9	203.3	189.6	204.0	190.3	204.8	191.0	205.5	191.6	47
44	197.8	191.0	198.5	191.7	199.3	192.4	200.0	193.1	200.7	193.8	201.4	194.5	202.1	195.2	46
45	194.5	194.5	195.2	195.2	195.9	195.9	196.6	196.6	197.3	197.3	198.0	198.0	198.7	198.7	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	D=275′		D=276′		D=277′		D=278′		D=279′		D=280′		D=281′		

Plane Traverse Table

Course.	D=282′		D=283′		D=284′		D=285′		D=286′		D=287′		D=288′		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	282.0	0.0	283.0	0.0	284.0	0.0	285.0	0.0	286.0	0.0	287.0	0.0	288.0	0.0	90
1	282.0	4.9	283.0	4.9	284.0	5.0	285.0	5.0	286.0	5.0	287.0	5.0	288.0	5.0	89
2	281.8	9.8	282.8	9.9	283.8	9.9	284.8	9.9	285.8	10.0	286.8	10.0	287.8	10.1	88
3	281.6	14.8	282.6	14.8	283.6	14.9	284.6	14.9	285.6	15.0	286.6	15.0	287.6	15.1	87
4	281.3	19.7	282.3	19.7	283.3	19.8	284.3	19.9	285.3	20.0	286.3	20.0	287.3	20.1	86
5	280.9	24.6	281.9	24.7	282.9	24.8	283.9	24.8	284.9	24.9	285.9	25.0	286.9	25.1	85
6	280.5	29.5	281.4	29.6	282.4	29.7	283.4	29.8	284.4	29.9	285.4	30.0	286.4	30.1	84
7	279.9	34.4	280.9	34.5	281.9	34.6	282.9	34.7	283.9	34.9	284.9	35.0	285.9	35.1	83
8	279.3	39.2	280.2	39.4	281.2	39.5	282.2	39.7	283.2	39.8	284.2	39.9	285.2	40.1	82
9	278.5	44.1	279.5	44.3	280.5	44.4	281.5	44.6	282.5	44.7	283.5	44.9	284.5	45.1	81
10	277.7	49.0	278.7	49.1	279.7	49.3	280.7	49.5	281.7	49.7	282.6	49.8	283.6	50.0	80
11	276.8	53.8	277.8	54.0	278.8	54.2	279.8	54.4	280.7	54.6	281.7	54.8	282.7	55.0	79
12	275.8	58.6	276.8	58.8	277.8	59.0	278.8	59.3	279.8	59.5	280.7	59.7	281.7	59.9	78
13	274.8	63.4	275.7	63.7	276.7	63.9	277.7	64.1	278.7	64.3	279.6	64.6	280.6	64.8	77
14	273.6	68.2	274.6	68.5	275.6	68.7	276.5	68.9	277.5	69.2	278.5	69.4	279.4	69.7	76
15	272.4	73.0	273.4	73.2	274.3	73.5	275.3	73.8	276.3	74.0	277.2	74.3	278.2	74.5	75
16	271.1	77.7	272.0	78.0	273.0	78.3	274.0	78.6	274.9	78.8	275.9	79.1	276.8	79.4	74
17	269.7	82.4	270.6	82.7	271.6	83.0	272.5	83.3	273.5	83.6	274.5	83.9	275.4	84.2	73
18	268.2	87.1	269.1	87.5	270.1	87.8	271.1	88.1	272.0	88.4	273.0	88.7	273.9	89.0	72
19	266.6	91.8	267.6	92.1	268.5	92.5	269.5	92.8	270.4	93.1	271.4	93.4	272.3	93.8	71
20	265.0	96.4	265.9	96.8	266.9	97.1	267.8	97.5	268.8	97.8	269.7	98.2	270.6	98.5	70
21	263.3	101.1	264.2	101.4	265.1	101.8	266.1	102.1	267.0	102.5	267.9	102.9	268.9	103.2	69
22	261.5	105.6	262.4	106.0	263.3	106.4	264.2	106 8	265.2	107.1	266.1	107.5	267.0	107.9	68
23	259.6	110.2	260.5	110.6	261.4	111.0	262.3	111.4	263.3	111.7	264.2	112.1	265.1	112.5	67
24	257.6	114.7	258.5	115.1	259.4	115.5	260.4	115.9	261.3	116.3	262.2	116.7	263.1	117.1	66
25	255.6	119.2	256.5	119.6	257.4	120.0	258.3	120.4	259.2	120.9	260.1	121.3	261.0	121.7	65
26	253.5	123.6	254.4	124.1	255.3	124.5	256.2	124.9	257.1	125.4	258.0	125.8	258.9	126.3	64
27	251.3	128.0	252.2	128.5	253.0	128.9	253.9	129.4	254.8	129.8	255.7	130.3	256.6	130.7	63
28	249.0	132.4	249.9	132.9	250.8	133.3	251.6	133.8	252.5	134.3	253.4	134.7	254.3	135.2	62
29	246.6	136.7	247.5	137.2	248.4	137.7	249.3	138.2	250.1	138.7	251.0	139.1	251.9	139.6	61
30	244.2	141.0	245.1	141.5	246.0	142.0	246.8	142.5	247.7	143.0	248.5	143.5	249.4	144.0	60
31	241.7	145.2	242.6	145.8	243.4	146.3	244.3	146.8	245.1	147.3	246.0	147.8	246.9	148.3	59
32	239.1	149.4	240.0	150.0	240.8	150.5	241.7	151.0	242.5	151.6	243.4	152.1	244.2	152.6	58
33	236.5	153.6	237.3	154.1	238.2	154.7	239.0	155.2	239.9	155.8	240.7	156.3	241.5	156.9	57
34	233.8	157.7	234.6	158.3	235.4	158.8	236.3	159.4	237.1	159.9	237.9	160.5	238.8	161.0	56
35	231.0	161.7	231.8	162.3	232.6	162.9	233.5	163.5	234.3	164.0	235.1	164.6	235.9	165.2	55
36	228.1	165.8	229.0	166.3	229.8	166.9	230.6	167.5	231.4	168.1	232.2	168.7	233.0	169.3	54
37	225.2	169.7	226.0	170.3	226.8	170.9	227.6	171.5	228.4	172.1	229.2	172.7	230.0	173.3	53
38	222.2	173.6	223.0	174.2	223.8	174.8	224.6	175.5	225.4	176.1	226.2	176.7	226.9	177.3	52
39	219.2	177.5	219.9	178.1	220.7	178.7	221.5	179.4	222.3	180.0	223.0	180.6	223.8	181.2	51
40	216.0	181.3	216.8	181.9	217.6	182.6	218.3	183.2	219.1	183.8	219.9	184.5	220.6	185.1	50
41	212.8	185.0	213.6	185.7	214.3	186.3	215.1	187.0	215.8	187.6	216.6	188.3	217.4	188.9	49
42	209.6	188.7	210.3	189.4	211.1	190.0	211.8	190.7	212.5	191.4	213.3	192.0	214.0	192.7	48
43	206.2	192.3	207.0	193.0	207.7	193.7	208.4	194.4	209.2	195.1	209.9	195.7	210.6	196.4	47
44	202.9	195.9	203.6	196.6	204.3	197.3	205.0	198.0	205.7	198.7	206.5	199.4	207.2	200.1	46
45	199.4	199.4	200.1	200.1	200.8	200.8	201.5	201.5	202.2	202.2	202.9	202.9	203.6	203.6	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	D=282′		D=283′		D=284′		D=285′		D=286′		D=287′		D=288′		

Plane Traverse Table

Course.	$D=289'$		$D=290'$		$D=291'$		$D=292'$		$D=293'$		$D=294'$		$D=295'$		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	289.0	0.0	290.0	0.0	291.0	0.0	292.0	0.0	293.0	0.0	294.0	0.0	295.0	0.0	90
1	289.0	5.0	290.0	5.1	291.0	5.1	292.0	5.1	293.0	5.1	294.0	5.1	295.0	5.1	89
2	288.8	10.1	289.8	10.1	290.8	10.2	291.8	10.2	292.8	10.2	293.8	10.3	294.8	10.3	88
3	288.6	15.1	289.6	15.2	290.6	15.2	291.6	15.3	292.6	15.3	293.6	15.4	294.6	15.4	87
4	288.3	20.2	289.3	20.2	290.3	20.3	291.3	20.4	292.3	20.4	293.3	20.5	294.3	20.6	86
5	287.9	25.2	288.9	25.3	289.9	25.4	290.9	25.4	291.9	25.5	292.9	25.6	293.9	25.7	85
6	287.4	30.2	288.4	30.3	289.4	30.4	290.4	30.5	291.4	30.6	292.4	30.7	293.4	30.8	84
7	286.8	35.2	287.8	35.3	288.8	35.5	289.8	35.6	290.8	35.7	291.8	35.8	292.8	36.0	83
8	286.2	40.2	287.2	40.4	288.2	40.5	289.2	40.6	290.1	40.8	291.1	40.9	292.1	41.1	82
9	285.4	45.2	286.4	45.4	287.4	45.5	288.4	45.7	289.4	45.8	290.4	46.0	291.4	46.1	81
10	284.6	50.2	285.6	50.4	286.6	50.5	287.6	50.7	288.5	50.9	289.5	51.1	290.5	51.2	80
11	283.7	55.1	284.7	55.3	285.7	55.5	286.6	55.7	287.6	55.9	288.6	56.1	289.6	56.3	79
12	282.7	60.1	283.7	60.3	284.6	60.5	285.6	60.7	286.6	60.9	287.6	61.1	288.6	61.3	78
13	281.6	65.0	282.6	65.2	283.5	65.5	284.5	65.7	285.5	65.9	286.5	66.1	287.4	66.4	77
14	280.4	69.9	281.4	70.2	282.4	70.4	283.3	70.6	284.3	70.9	285.3	71.1	286.2	71.4	76
15	279.2	74.8	280.1	75.1	281.1	75.3	282.1	75.6	283.0	75.8	284.0	76.1	284.9	76.4	75
16	277.8	79.7	278.8	79.9	279.7	80.2	280.7	80.5	281.6	80.8	282.6	81.0	283.6	81.3	74
17	276.4	84.5	277.3	84.8	278.3	85.1	279.2	85.4	280.2	85.7	281.2	86.0	282.1	86.2	73
18	274.9	89.3	275.8	89.6	276.8	89.9	277.7	90.2	278.7	90.5	279.6	90.9	280.6	91.2	72
19	273.3	94.1	274.2	94.4	275.1	94.7	276.1	95.1	277.0	95.4	278.0	95.7	278.9	96.0	71
20	271.6	98.8	272.5	99.2	273.5	99.5	274.4	99.9	275.3	100.2	276.3	100.6	277.2	100.9	70
21	269.8	103.6	270.7	103.9	271.7	104.3	272.6	104.6	273.5	105.0	274.5	105.4	275.4	105.7	69
22	268.0	108.3	268.9	108.6	269.8	109.0	270.7	109.4	271.7	109.8	272.6	110.1	273.5	110.5	68
23	266.0	112.9	266.9	113.3	267.9	113.7	268.8	114.1	269.7	114.5	270.6	114.9	271.5	115.3	67
24	264.0	117.5	264.9	118.0	265.8	118.4	266.8	118.8	267.7	119.2	268.6	119.6	269.5	120.0	66
25	261.9	122.1	262.8	122.6	263.7	123.0	264.6	123.4	265.5	123.8	266.5	124.2	267.4	124.7	65
26	259.8	126.7	260.7	127.1	261.5	127.6	262.4	128.0	263.3	128.4	264.2	128.9	265.1	129.3	64
27	257.5	131.2	258.4	131.7	259.3	132.1	260.2	132.6	261.1	133.0	262.0	133.5	262.8	133.9	63
28	255.2	135.7	256.1	136.1	256.9	136.6	257.8	137.1	258.7	137.6	259.6	138.0	260.5	138.5	62
29	252.8	140.1	253.6	140.6	254.5	141.1	255.4	141.6	256.3	142.0	257.1	142.5	258.0	143.0	61
30	250.3	144.5	251.1	145.0	252.0	145.5	252.9	146.0	253.7	146.5	254.6	147.0	255.5	147.5	60
31	247.7	148.8	248.6	149.4	249.4	149.9	250.3	150.4	251.2	150.9	252.0	151.4	252.9	151.9	59
32	245.1	153.1	245.9	153.7	246.8	154.2	247.6	154.7	248.5	155.3	249.3	155.8	250.2	156.3	58
33	242.4	157.4	243.2	157.9	244.1	158.5	244.9	159.0	245.7	159.6	246.6	160.1	247.4	160.7	57
34	239.6	161.6	240.4	162.2	241.2	162.7	242.1	163.3	242.9	163.8	243.7	164.4	244.6	165.0	56
35	236.7	165.8	237.6	166.3	238.4	166.9	239.2	167.5	240.0	168.1	240.8	168.6	241.6	169.2	55
36	233.8	169.9	234.6	170.5	235.4	171.0	236.2	171.6	237.0	172.2	237.9	172.8	238.7	173.4	54
37	230.8	173.9	231.6	174.5	232.4	175.1	233.2	175.7	234.0	176.3	234.8	176.9	235.6	177.5	53
38	227.7	177.9	228.5	178.5	229.3	179.2	230.1	179.8	230.9	180.4	231.7	181.0	232.5	181.6	52
39	224.6	181.9	225.4	182.5	226.1	183.1	226.9	183.8	227.7	184.4	228.5	185.0	229.3	185.6	51
40	221.4	185.8	222.2	186.4	222.9	187.1	223.7	187.7	224.5	188.3	225.2	189.0	226.0	189.6	50
41	218.1	189.6	218.9	190.3	219.6	190.9	220.4	191.6	221.1	192.2	221.9	192.9	222.6	193.5	49
42	214.8	193.4	215.5	194.0	216.3	194.7	217.0	195.4	217.7	196.1	218.5	196.7	219.2	197.4	48
43	211.4	197.1	212.1	197.8	212.8	198.5	213.6	199.1	214.3	199.8	215.0	200.5	215.7	201.2	47
44	207.9	200.8	208.6	201.5	209.3	202.1	210.0	202.8	210.8	203.5	211.5	204.2	212.2	204.9	46
45	204.4	204.4	205.1	205.1	205.8	205.8	206.5	206.5	207.2	207.2	207.9	207.9	208.6	208.6	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	$D=289'$		$D=290'$		$D=291'$		$D=292'$		$D=293'$		$D=294'$		$D=295'$		

Plane Traverse Table

Course.	D=296′		D=297′		D=298′		D=299′		D=300′		D=400′		D=500′		Course.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	296.0	0.0	297.0	0.0	298.0	0.0	299.0	0.0	300.0	0.0	400.0	0.0	500.0	0.0	90
1	296.0	5.2	297.0	5.2	298.0	5.2	299.0	5.2	300.0	5.2	399.9	7.0	499.9	8.8	89
2	295.8	10.3	296.8	10.4	297.8	10.4	298.8	10.4	299.8	10.5	399.8	13.9	499.7	17.4	88
3	295.6	15.5	296.6	15.5	297.6	15.6	298.6	15.6	299.6	15.7	399.4	20.9	499.3	26.2	87
4	295.3	20.6	296.3	20.7	297.3	20.8	298.3	20.9	299.3	20.9	399.0	27.9	498.8	34.8	86
5	294.9	25.8	295.9	25.9	296.9	26.0	297.9	26.1	298.9	26.1	398.5	34.9	498.1	43.6	85
6	294.4	30.9	295.4	31.0	296.4	31.1	297.4	31.3	298.4	31.4	397.8	41.8	497.3	52.3	84
7	293.8	36.1	294.8	36.2	295.8	36.3	296.8	36.4	297.8	36.6	397.0	48.7	496.3	61.0	83
8	293.1	41.2	294.1	41.3	295.1	41.5	296.1	41.6	297.1	41.8	396.1	55.7	495.1	69.6	82
9	292.4	46.3	293.3	46.5	294.3	46.6	295.3	46.8	296.3	46.9	395.1	62.6	493.8	78.2	81
10	291.5	51.4	292.5	51.6	293.5	51.7	294.5	51.9	295.4	52.1	393.9	69.5	492.4	86.8	80
11	290.6	56.5	291.5	56.7	292.5	56.9	293.5	57.1	294.5	57.2	392.6	76.3	490.8	95.4	79
12	289.5	61.5	290.5	61.7	291.5	62.0	292.5	62.2	293.4	62.4	391.3	83.1	489.1	104.0	78
13	288.4	66.6	289.4	66.8	290.4	67.0	291.3	67.3	292.3	67.5	389.8	90.0	487.2	112.4	77
14	287.2	71.6	288.2	71.9	289.1	72.1	290.1	72.3	291.1	72.6	388.1	96.7	485.1	121.0	76
15	285.9	76.6	286.9	76.9	287.8	77.1	288.8	77.4	289.8	77.6	386.3	103.5	483.0	129.4	75
16	284.5	81.6	285.5	81.9	286.5	82.1	287.4	82.4	288.4	82.7	384.5	110.2	480.6	137.8	74
17	283.1	86.5	284.0	86.8	285.0	87.1	285.9	87.4	286.9	87.7	382.5	117.0	478.1	146.2	73
18	281.5	91.5	282.5	91.8	283.4	92.1	284.4	92.4	285.3	92.7	380.4	123.6	475.5	154.5	72
19	279.9	96.4	280.8	96.7	281.8	97.0	282.7	97.3	283.7	97.7	378.2	130.2	472.8	162.8	71
20	278.1	101.2	279.1	101.6	280.0	101.9	281.0	102.3	281.9	102.6	375.9	136.8	469.9	171.0	70
21	276.3	106.1	277.3	106.4	278.2	106.8	279.1	107.2	280.1	107.5	373.4	143.4	466.8	179.2	69
22	274.4	110.9	275.4	111.3	276.3	111.6	277.2	112.0	278.2	112.4	370.9	149.8	463.8	187.3	68
23	272.5	115.7	273.4	116.0	274.3	116.4	275.2	116.8	276.2	117.2	368.2	156.3	460.2	195.4	67
24	270.4	120.4	271.3	120.8	272.2	121.2	273.2	121.6	274.1	122.0	365.4	162.7	456.8	203.4	66
25	268.3	125.1	269.2	125.5	270.1	125.9	271.0	126.4	271.9	126.8	362.5	169.0	453.1	211.3	65
26	266.0	129.8	266.9	130.2	267.8	130.6	268.7	131.1	269.6	131.5	359.5	175.4	449.4	219.2	64
27	263.7	134.4	264.6	134.8	265.5	135.3	266.4	135.7	267.3	136.2	356.4	181.6	445.5	227.0	63
28	261.3	139.0	262.2	139.4	263.1	139.9	264.0	140.4	264.9	140.8	353.1	187.8	441.5	234.7	62
29	258.9	143.5	259.8	144.0	260.6	144.5	261.5	145.0	262.4	145.4	349.8	193.9	437.3	242.4	61
30	256.3	148.0	257.2	148.5	258.1	149.0	258.9	149.5	259.8	150.0	346.4	200.0	433.0	250.0	60
31	253.7	152.5	254.6	153.0	255.4	153.5	256.3	154.0	257.1	154.5	342.9	206.0	428.6	257.5	59
32	251.0	156.9	251.9	157.4	252.7	157.9	253.6	158.4	254.4	159.0	339.2	211.9	424.0	265.0	58
33	248.2	161.2	249.1	161.8	249.9	162.3	250.8	162.8	251.6	163.4	335.5	217.8	419.3	272.3	57
34	245.4	165.5	246.2	166.1	247.1	166.6	247.9	167.2	248.7	167.8	331.6	223.7	414.5	279.6	56
35	242.5	169.8	243.3	170.4	244.1	170.9	244.9	171.5	245.7	172.1	327.7	229.4	409.6	286.8	55
36	239.5	174.0	240.3	174.6	241.1	175.2	241.9	175.7	242.7	176.3	323.6	235.1	404.5	293.9	54
37	236.4	178.1	237.2	178.7	238.0	179.3	238.8	179.9	239.6	180.5	319.4	240.7	399.3	300.9	53
38	233.3	182.2	234.0	182.9	234.8	183.5	235.6	184.1	236.4	184.7	315.2	246.3	394.0	307.8	52
39	230.0	186.3	230.8	186.9	231.6	187.5	232.4	188.2	233.1	188.8	310.9	251.7	388.6	314.7	51
40	226.7	190.3	227.5	190.9	228.3	191.6	229.0	192.2	229.8	192.8	306.4	257.1	383.0	321.4	50
41	223.4	194.2	224.1	194.8	224.9	195.5	225.7	196.2	226.4	196.8	301.9	262.4	377.3	328.0	49
42	220.0	198.1	220.7	198.7	221.5	199.4	222.2	200.1	222.9	200.7	297.3	267.7	371.6	334.6	48
43	216.5	201.9	217.2	202.6	217.9	203.2	218.7	203.9	219.4	204.6	292.6	272.8	365.7	341.0	47
44	212.9	205.6	213.6	206.3	214.4	207.0	215.1	207.7	215.8	208.4	287.7	277.9	359.7	347.3	46
45	209.3	209.3	210.0	210.0	210.7	210.7	211.4	211.4	212.1	212.1	282.8	282.8	353.5	353.5	45
Course.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Course.
	D=296′		D=297′		D=298′		D=299′		D=300′		D=400′		D=500′		

★ Total correction of the observed altitude of a Star or Planet.

Star's Altitude	Height of the eye above the sea in metres and feet. [Correction to be *subtracted from* the observed altitude of Star or Planet.]													Star's Altitude
	3m 10′	4m 13′	5m 16′	6m 20′	7m 23′	8m 26′	9m 30′	10m 33′	11m 36′	12m 39′	13m 43′	14m 46′	15m 49′	
8° 0′	9.8	10.3	10.7	11.1	11.5	11.8	12.1	12.4	12.7	13.0	13.3	13.6	13.8	8° 0′
10	9.6	10.1	10.5	10.9	11.3	11.6	11.9	12.2	12.5	12.8	13.1	13.4	13.6	10
20	9.5	10.0	10.4	10.8	11.2	11.5	11.8	12.1	12.4	12.7	13.0	13.3	13.5	20
30	9.4	9.9	10.3	10.7	11.1	11.4	11.7	12.0	12.3	12.6	12.9	13.2.	13.4	30
40	9.3	9.8	10.2	10.6	11.0	11.3	11.6	11.9	12.2	12.5	12.8	13.1	13.3	40
50	9.2	9.7	10.1	10.5	10.9	11.2	11.5	11.8	12.1	12.4	12.7	13.0	13.2	50
9 0	9.1	9.6	10.0	10.4	10.8	11.1	11.4	11.7	12.0	12.3	12.6	12.9	13.1	9 0
20	8.9	9.4	9.8	10.2	10.6	10.9	11.2	11.5	11.8	12.1	12.4	12.7	12.9	20
40	8.7	9.2	9.6	10.0	10.4	10.7	11.0	11.3	11.6	11.9	12.2	12.5	12.7	40
10 0	8.5	9.0	9.4	9.8	10.2	10.5	10.8	11.1	11.4	11.7	12.0	12.3	12.5	10 0
20	8.4	8.9	9.3	9.7	10.1	10.4	10.7	11.0	11.3	11.6	11.9	12.2	12.4	20
40	8.2	8.7	9.1	9.5	9.9	10.2	10.5	10.8	11.1	11.4	11.7	12.0	12.2.	40
11 0	8.0	8.5	8.9	9.3	9.7	10.0	10.3	10.6	10.9	11.2	11.5	11.8	12.0	11 0
30	7.8	8.3	8.7	9.1	9.5	9.8	10.1	10.4	10.7	11.0	11.3	11.6	11.8	30
12 0	7.7	8.2	8.6	9.0	9.4	9.7	10.0	10.3	10.6	10.9	11.2	11.5	11.7	12 0
30	7.5	8.0	8.4	8.8	9.2	9.5	9.8	10.1	10.4	10.7	11.0	11.3	11.5	30
13 0	7.3	7.8	8.2	8.6	9.0	9.3	9.6	9.9	10.2	10.5	10.8	11.1	11.3	13 0
30	7.2	7.7	8.1	8.5	8.9	9.2	9.5	9.8	10.1	10.4	10.7	11.0	11.2.	30
14 0	7.0	7.5	7.9	8.3	8.7	9.0	9.3	9.6	9.9	10.2	10.5	10.8	11.0	14 0
30	6.9	7.4	7.8	8.2	8.6	8.9	9.2	9.5	9.8	10.1	10.4	10.7	10.9	30
15 0	6.8	7.3	7.7	8.1	8.5	8.8	9.1	9.4	9.7	10.0	10.3	10.6	10.8	15 0
30	6.7	7.2	7.6	8.0	8.4	8.7	9.0	9.3	9.6	9.9	10.2	10.5	10.7	30
16 0	6.5	7.0	7.4	7.8	8.2	8.5	8.8	9.1	9.4	9.7	10.0	10.3	10.5	16 0
17 0	6.3	6.8	7.2	7.6	8.0	8.3	8.6	8.9	9.2	9.5	9.8	10.1	10.3	17 0
18 0	6.1	6.6	7.0	7.4	7.8	8.1	8.4	8.7	9.0	9.3	9.6	9.9	10.1	18 0
19 0	6.0	6.5	6.9	7.3	7.7	8.0	8.3	8.6	8.9	9.2	9.5	9.8	10.0	19 0
20 0	5.8	6.3	6.7	7.1	7.5	7.8	8.1	8.4	8.7	9.0	9.3	9.6	9.8	20 0
22 0	5.6	6.1	6.5	6.9	7.3	7.6	7.9	8.2	8.5	8.8	9.1	9.4	9.6	22 0
24 0	5.4	5.9	6.3	6.7	7.1	7.4	7.7	8.0	8.3	8.6	8.9	9.2	9.4	24 0
26 0	5.2	5.7	6.1	6.5	6.9	7.2	7.5	7.8	8.1	8.4	8.7	9.0	9.2	26 0
28 0	5.0	5.5	5.9	6.3	6.7	7.0	7.3	7.6	7.9	8.2	8.5	8.8	9.0	28 0
30 0	4.9	5.4	5.8	6.2	6.6	6.9	7.2	7.5	7.8	8.1	8.4	8.7	8.9	30 0
32 0	4.7	5.2	5.6	6.0	6.4	6.7	7.0	7.3	7.6	7.9	8.2	8.5	8.7	32 0
34 0	4.6	5.1	5.5	5.9	6.3	6.6	6.9	7.2	7.5	7.8	8.1	8.4	8.6	34 0
36 0	4.5	5.0	5.4	5.8	6.2	6.5	6.8	7.1	7.4	7.7	8.0	8.3	8.5	36 0
38 0	4.4	4.9	5.3	5.7	6.1	6.4	6.7	7.0	7.3	7.6	7.9	8.2	8.4	38 0
40 0	4.3	4.8	5.2	5.6	6.0	6.3	6.6	6.9	7.2	7.5	7.8	8.1	8.3	40 0
45 0	4.2	4.7	5.1	5.5	5.9	6.2	6.5	6.8	7.1	7.4	7.7	8.0	8.2	45 0
50 0	4.0	4.5	4.9	5.3	5.7	6.0	6.3	6.6	6.9	7.2	7.5	7.8	8.0	50 0
55 0	3.9	4.4	4.8	5.2	5.6	5.9	6.2	6.5	6.8	7.1	7.4	7.7	7.9	55 0
60 0	3.7	4.2	4.6	5.0	5.4	5.7	6.0	6.3	6.6	6.9	7.2	7.5	7.7	60 0
65 0	3.6	4.1	4.5	4.9	5.3	5.6	5.9	6.2	6.5	6.8	7.1	7.4	7.6	65 0
70 0	3.5	4.0	4.4	4.8	5.2	5.5	5.8	6.1	6.4	6.7	7.0	7.3	7.5	70 0
75 0	3.4	3.9	4.3	4.7	5.1	5.4	5.7	6.0	6.3	6.6	6.9	7.2	7.4	75 0
80 0	3.4	3.9	4.3	4.7	5.1	5.4	5.7	6.0	6.3	6.6	6.9	7.2	7.4	80 0
85 0	3.3	3.8	4.2	4.6	5.0	5.3	5.6	5.9	6.2	6.5	6.8	7.1	7.3	85 0
90 0 Dip of Sea	3.2	3.7	4.1	4.5	4.9	5.2	5.5	5.8	6.1	6.4	6.7	7.0	7.2	90 0 Horizon.

Correction for parallax to be *subtracted from* Star's Correction	Planet's Altitude	Planet's horizontal parallax. 6″	9″	12″	15″	18″	21″	24″	27″	30″	33″	Planet's Altitude	Additional Correction to be *added to* Correction given for 15m
	10°	0′.1	0′.1	0′.2	0′.2	0′.3	0′.3	0′.4	0′.4	0′.5	0′.5	10°	16m or 52 ′.2
	30	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.5	30	17 ,, 56 .4
	50	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.4	50	18 ,, 59 .6
	70	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	70	19 ,, 62 .8
	90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	90	20 ,, 66 1.0

A

Conversion of Intervals of Mean Solar Time into Equivalent Intervals of Sidereal Time.

[Correction to be *added to* the Interval of Mean Time.]

Mean Time	0m	4m	8m	12m	16m	20m	24m	28m	32m	36m	40m	44m	48m	52m	56m	Mean Time
h	m s	m s	m s	m s	m s	m s	m s	m s	m s	m s	m s	m s	m s	m s	m s	h
0	0 0	0 1	0 1	0 2	0 3	0 3	0 4	0 5	0 5	0 6	0 7	0 7	0 8	0 9	0 9	0
1	0 10	0 11	0 11	0 12	0 12	0 13	0 14	0 14	0 15	0 16	0 16	0 17	0 18	0 18	0 19	1
2	0 20	0 20	0 21	0 22	0 22	0 23	0 24	0 24	0 25	0 26	0 26	0 27	0 28	0 28	0 29	2
3	0 30	0 30	0 31	0 32	0 32	0 33	0 34	0 34	0 35	0 36	0 36	0 37	0 37	0 38	0 39	3
4	0 39	0 40	0 41	0 41	0 42	0 43	0 43	0 44	0 45	0 45	0 46	0 47	0 47	0 48	0 49	4
5	0 49	0 50	0 51	0 51	0 52	0 53	0 53	0 54	0 55	0 55	0 56	0 57	0 57	0 58	0 58	5
6	0 59	1 0	1 0	1 1	1 2	1 2	1 3	1 4	1 4	1 5	1 6	1 6	1 7	1 8	1 8	6
7	1 9	1 10	1 10	1 11	1 12	1 12	1 13	1 14	1 14	1 15	1 16	1 16	1 17	1 18	1 18	7
8	1 19	1 20	1 20	1 21	1 21	1 22	1 23	1 23	1 24	1 25	1 25	1 26	1 27	1 27	1 28	8
9	1 29	1 29	1 30	1 31	1 31	1 32	1 33	1 33	1 34	1 35	1 35	1 36	1 37	1 37	1 38	9
10	1 39	1 39	1 40	1 41	1 41	1 42	1 43	1 43	1 44	1 45	1 45	1 46	1 46	1 47	1 48	10
11	1 48	1 49	1 50	1 50	1 51	1 52	1 52	1 53	1 54	1 54	1 55	1 56	1 56	1 57	1 58	11
12	1 58	1 59	2 0	2 0	2 1	2 2	2 2	2 3	2 4	2 4	2 5	2 6	2 6	2 7	2 7	12
13	2 8	2 9	2 9	2 10	2 11	2 11	2 12	2 13	2 13	2 14	2 15	2 15	2 16	2 17	2 17	13
14	2 18	2 19	2 19	2 20	2 21	2 21	2 22	2 23	2 23	2 24	2 25	2 25	2 26	2 27	2 27	14
15	2 28	2 29	2 29	2 30	2 30	2 31	2 32	2 32	2 33	2 34	2 34	2 35	2 36	2 36	2 37	15
16	2 38	2 38	2 39	2 40	2 40	2 41	2 42	2 42	2 43	2 44	2 44	2 45	2 46	2 46	2 47	16
17	2 48	2 48	2 49	2 50	2 50	2 51	2 52	2 52	2 53	2 53	2 54	2 55	2 55	2 56	2 57	17
18	2 57	2 58	2 59	2 59	3 0	3 1	3 1	3 2	3 3	3 3	3 4	3 5	3 5	3 6	3 7	18
19	3 7	3 8	3 9	3 9	3 10	3 11	3 11	3 12	3 13	3 13	3 14	3 15	3 15	3 16	3 16	19
20	3 17	3 18	3 18	3 19	3 20	3 20	3 21	3 22	3 22	3 23	3 24	3 24	3 25	3 26	3 26	20
21	3 27	3 28	3 28	3 29	3 30	3 30	3 31	3 32	3 32	3 33	3 34	3 34	3 35	3 36	3 36	21
22	3 37	3 38	3 38	3 39	3 39	3 40	3 41	3 41	3 42	3 43	3 43	3 44	3 45	3 45	3 46	22
23	3 47	3 47	3 48	3 49	3 49	3 50	3 51	3 51	3 52	3 53	3 53	3 54	3 55	3 55	3 56	23

This table gives the *Acceleration* of { Sidereal on Mean Solar Time. / the R.A.M.S. (Sidereal Time at Greenwich Mean Noon).

Conversion of Time into Arc and vice-versa

	0h	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	11h		0m	1m	2m	3m
m	°	°	°	°	°	°	°	°	°	°	°	°	s	′	′	′	′
0	0	15	30	45	60	75	90	105	120	135	150	165	0	0	15	30	45
4	1	16	31	46	61	76	91	106	121	136	151	166	4	1	16	31	46
8	2	17	32	47	62	77	92	107	122	137	152	167	8	2	17	32	47
12	3	18	33	48	63	78	93	108	123	138	153	168	12	3	18	33	48
16	4	19	34	49	64	79	94	109	124	139	154	169	16	4	19	34	49
20	5	20	35	50	65	80	95	110	125	140	155	170	20	5	20	35	50
24	6	21	36	51	66	81	96	111	126	141	156	171	24	6	21	36	51
28	7	22	37	52	67	82	97	112	127	142	157	172	28	7	22	37	52
32	8	23	38	53	68	83	98	113	128	143	158	173	32	8	23	38	53
36	9	24	39	54	69	84	99	114	129	144	159	174	36	9	24	39	54
40	10	25	40	55	70	85	100	115	130	145	160	175	40	10	25	40	55
44	11	26	41	56	71	86	101	116	131	146	161	176	44	11	26	41	56
48	12	27	42	57	72	87	102	117	132	147	162	177	48	12	27	42	57
52	13	28	43	58	73	88	103	118	133	148	163	178	52	13	28	43	58
56	14	29	44	59	74	89	104	119	134	149	164	179	56	14	29	44	59

R

Conversion of Intervals of Sidereal Time into Equivalent Intervals of Mean Solar Time.

[Correction to be *subtracted from* the Interval of Sidereal Time.]

Sidereal Time	0m	4m	8m	12m	16m	20m	24m	28m	32m	36m	40m	44m	48m	52m	56m	Sidereal Time
h	m s	m s	m s	m s	m s	m s	m s	m s	m s	m s	m s	m s	m s	m s	m s	h
0	0 0	0 1	0 1	0 2	0 3	0 3	0 4	0 5	0 5	0 6	0 7	0 7	0 8	0 9	0 9	0
1	0 10	0 10	0 11	0 12	0 12	0 13	0 14	0 14	0 15	0 16	0 16	0 17	0 18	0 18	0 19	1
2	0 20	0 20	0 21	0 22	0 22	0 23	0 24	0 24	0 25	0 26	0 26	0 27	0 28	0 28	0 29	2
3	0 29	0 30	0 31	0 31	0 32	0 33	0 33	0 34	0 35	0 35	0 36	0 37	0 37	0 38	0 39	3
4	0 39	0 40	0 41	0 41	0 42	0 43	0 43	0 44	0 45	0 45	0 46	0 47	0 47	0 48	0 48	4
5	0 49	0 50	0 50	0 51	0 52	0 52	0 53	0 54	0 54	0 55	0 56	0 56	0 57	0 58	0 58	5
6	0 59	1 0	1 0	1 1	1 2	1 2	1 3	1 4	1 4	1 5	1 6	1 6	1 7	1 7	1 8	6
7	1 9	1 9	1 10	1 11	1 11	1 12	1 13	1 13	1 14	1 15	1 15	1 16	1 17	1 17	1 18	7
8	1 19	1 19	1 20	1 21	1 21	1 22	1 23	1 23	1 24	1 25	1 25	1 26	1 27	1 27	1 28	8
9	1 28	1 29	1 30	1 30	1 31	1 32	1 32	1 33	1 34	1 34	1 35	1 36	1 36	1 37	1 38	9
10	1 38	1 39	1 40	1 40	1 41	1 42	1 42	1 43	1 44	1 44	1 45	1 46	1 46	1 47	1 47	10
11	1 48	1 49	1 49	1 50	1 51	1 51	1 52	1 53	1 53	1 54	1 55	1 55	1 56	1 57	1 57	11
12	1 58	1 59	1 59	2 0	2 1	2 1	2 2	2 3	2 3	2 4	2 5	2 5	2 6	2 6	2 7	12
13	2 8	2 8	2 9	2 10	2 10	2 11	2 12	2 12	2 13	2 14	2 14	2 15	2 16	2 16	2 17	13
14	2 18	2 18	2 19	2 20	2 20	2 21	2 22	2 22	2 23	2 24	2 24	2 25	2 25	2 26	2 27	14
15	2 27	2 28	2 29	2 29	2 30	2 31	2 31	2 32	2 33	2 33	2 34	2 35	2 35	2 36	2 37	15
16	2 37	2 38	2 39	2 39	2 40	2 41	2 41	2 42	2 43	2 43	2 44	2 44	2 45	2 46	2 46	16
17	2 47	2 48	2 48	2 49	2 50	2 50	2 51	2 52	2 52	2 53	2 54	2 54	2 55	2 56	2 56	17
18	2 57	2 58	2 58	2 59	3 0	3 0	3 1	3 2	3 2	3 3	3 3	3 4	3 5	3 5	3 6	18
19	3 7	3 7	3 8	3 9	3 9	3 10	3 11	3 11	3 12	3 13	3 13	3 14	3 15	3 15	3 16	19
20	3 17	3 17	3 18	3 19	3 19	3 20	3 21	3 21	3 22	3 22	3 23	3 24	3 24	3 25	3 26	20
21	3 26	3 27	3 28	3 28	3 29	3 30	3 30	3 31	3 32	3 32	3 33	3 34	3 34	3 35	3 36	21
22	3 36	3 37	3 38	3 38	3 39	3 40	3 40	3 41	3 41	3 42	3 43	3 43	3 44	3 45	3 45	22
23	3 46	3 47	3 47	3 48	3 49	3 49	3 50	3 51	3 51	3 52	3 53	3 53	3 54	3 55	3 55	23

This table gives the *Retardation* of Mean Solar on Sidereal Time.

Conversion of Time into Arc and vice-versa.

	12h	13h	14h	15h	16h	17h	18h	19h	20h	21h	22h	23h		0m	1m	2m	3m
m	°	°	°	°	°	°	°	°	°	°	°	°	s	′	′	′	′
0	180	195	210	225	240	255	270	285	300	315	330	345	0	0	15	30	45
4	181	196	211	226	241	256	271	286	301	316	331	346	4	1	16	31	46
8	182	197	212	227	242	257	272	287	302	317	332	347	8	2	17	32	47
12	183	198	213	228	243	258	273	288	303	318	333	348	12	3	18	33	48
16	184	199	214	229	244	259	274	289	304	319	334	349	16	4	19	34	49
20	185	200	215	230	245	260	275	290	305	320	335	350	20	5	20	35	50
24	186	201	216	231	246	261	276	291	306	321	336	351	24	6	21	36	51
28	187	202	217	232	247	262	277	292	307	322	337	352	28	7	22	37	52
32	188	203	218	233	248	263	278	293	308	323	338	353	32	8	23	38	53
36	189	204	219	234	249	264	279	294	309	324	339	354	36	9	24	39	54
40	190	205	220	235	250	265	280	295	310	325	340	355	40	10	25	40	55
44	191	206	221	236	251	266	281	296	311	326	341	356	44	11	26	41	56
48	192	207	222	237	252	267	282	297	312	327	342	357	48	12	27	42	57
52	193	208	223	238	253	268	283	298	313	328	343	358	52	13	28	43	58
56	194	209	224	239	254	269	284	299	314	329	344	359	56	14	29	44	59

⊙ Total correction of the observed altitude of the Sun's lower limb.

Sun's Altitude	Height of the eye above the sea in metres and feet. [Correction to be *added to* the observed altitude of Sun's lower limb.]												Sun's Altitude
	3m	4m	5m	6m	7m	8m	9m	10m	11m	12m	13m	14m	15m	
	10′	13′	16′	20′	23′	26′	30′	33′	36′	39′	43′	46′	49′	
° ′	′	′	′	′	′	′	′	′	′	′	′	′	′	° ′
8 0	6.4	5.9	5.5	5.1	4.7	4.4	4.1	3.8	3.5	3.2	2.9	2.6	2.4	8 0
10	6.5	6.0	5.6	5.2	4.8	4.5	4.2	3.9	3.6	3.3	3.0	2.7	2.5	10
20	6.6	6.1	5.7	5.3	4.9	4.6	4.3	4.0	3.7	3.4	3.1	2.8	2.6	20
30	6.7	6.2	5.8	5.4	5.0	4.7	4.4	4.1	3.8	3.5	3.2	2.9	2.7	30
40	6.9	6.4	6.0	5.6	5.2	4.9	4.6	4.3	4.0	3.7	3.4	3.1	2.9	40
50	7.0	6.5	6.1	5.7	5.3	5.0	4.7	4.4	4.1	3.8	3.5	3.2	3.0	50
9 0	7.1	6.6	6.2	5.8	5.4	5.1	4.8	4.5	4.2	3.9	3.6	3.3	3.1	9 0
20	7.3	6.8	6.4	6.0	5.6	5.3	5.0	4.7	4.4	4.1	3.8	3.5	3.3	20
40	7.5	7.0	6.6	6.2	5.8	5.5	5.2	4.9	4.6	4.3	4.0	3.7	3.5	40
10 0	7.6	7.1	6.7	6.3	5.9	5.6	5.3	5.0	4.7	4.4	4.1	3.8	3.6	10 0
20	7.8	7.3	6.9	6.5	6.1	5.8	5.5	5.2	4.9	4.6	4.3	4.0	3.8	20
40	8.0	7.5	7.1	6.7	6.3	6.0	5.7	5.4	5.1	4.8	4.5	4.2	4.0	40
11 0	8.1	7.6	7.2	6.8	6.4	6.1	5.8	5.5	5.2	4.9	4.6	4.3	4.1	11 0
30	8.3	7.8	7.4	7.0	6.6	6.3	6.0	5.7	5.4	5.1	4.8	4.5	4.3	30
12 0	8.5	8.0	7.6	7.2	6.8	6.5	6.2	5.9	5.6	5.3	5.0	4.7	4.5	12 0
30	8.7	8.2	7.8	7.4	7.0	6.7	6.4	6.1	5.8	5.5	5.2	4.9	4.7	30
13 0	8.8	8.3	7.9	7.5	7.1	6.8	6.5	6.2	5.9	5.6	5.3	5.0	4.8	13 0
30	9.0	8.5	8.1	7.7	7.3	7.0	6.7	6.4	6.1	5.8	5.5	5.2	5.0	30
14 0	9.1	8.6	8.2	7.8	7.4	7.1	6.8	6.5	6.2	5.9	5.6	5.3	5.1	14 0
30	9.2	8.7	8.3	7.9	7.5	7.2	6.9	6.6	6.3	6.0	5.7	5.4	5.2	30
15 0	9.3	8.8	8.4	8.0	7.6	7.3	7.0	6.7	6.4	6.1	5.8	5.5	5.3	15 0
30	9.4	8.9	8.5	8.1	7.7	7.4	7.1	6.8	6.5	6.2	5.9	5.6	5.4	30
16 0	9.6	9.1	8.7	8.3	7.9	7.6	7.3	7.0	6.7	6.4	6.1	5.8	5.6	16 0
17 0	9.8	9.3	8.9	8.5	8.1	7.8	7.5	7.2	6.9	6.6	6.3	6.0	5.8	17 0
18 0	10.0	9.5	9.1	8.7	8.3	8.0	7.7	7.4	7.1	6.8	6.5	6.2	6.0	18 0
19 0	10.2	9.7	9.3	8.9	8.5	8.2	7.9	7.6	7.3	7.0	6.7	6.4	6.2	19 0
20 0	10.3	9.8	9.4	9.0	8.6	8.3	8.0	7.7	7.4	7.1	6.8	6.5	6.3	20 0
22 0	10.6	10.1	9.7	9.3	8.9	8.6	8.3	8.0	7.7	7.4	7.1	6.8	6.6	22 0
24 0	10.8	10.3	9.9	9.5	9.1	8.8	8.5	8.2	7.9	7.6	7.3	7.0	6.8	24 0
26 0	10.9	10.4	10.0	9.6	9.2	8.9	8.6	8.3	8.0	7.7	7.4	7.1	6.9	26 0
28 0	11.1	10.6	10.2	9.8	9.4	9.1	8.8	8.5	8.2	7.9	7.6	7.3	7.1	28 0
30 0	11.3	10.8	10.4	10.0	9.6	9.3	9.0	8.7	8.4	8.1	7.8	7.5	7.3	30 0
32 0	11.4	10.9	10.5	10.1	9.7	9.4	9.1	8.8	8.5	8.2	7.9	7.6	7.4	32 0
34 0	11.5	11.0	10.6	10.2	9.8	9.5	9.2	8.9	8.6	8.3	8.0	7.7	7.5	34 0
36 0	11.6	11.1	10.7	10.3	9.9	9.6	9.3	9.0	8.7	8.4	8.1	7.8	7.6	36 0
38 0	11.7	11.2	10.8	10.4	10.0	9.7	9.4	9.1	8.8	8.5	8.2	7.9	7.7	38 0
40 0	11.8	11.3	10.9	10.5	10.1	9.8	9.5	9.2	8.9	8.6	8.3	8.0	7.8	40 0
45 0	11.9	11.4	11.0	10.6	10.2	9.9	9.6	9.3	9.0	8.7	8.4	8.1	7.9	45 0
50 0	12.1	11.6	11.2	10.8	10.4	10.1	9.8	9.5	9.2	8.9	8.6	8.3	8.1	50 0
55 0	12.2	11.7	11.3	10.9	10.5	10.2	9.9	9.6	9.3	9.0	8.7	8.4	8.2	55 0
60 0	12.3	11.8	11.4	11.0	10.6	10.3	10.0	9.7	9.4	9.1	8.8	8.5	8.3	60 0
65 0	12.4	11.9	11.5	11.1	10.7	10.4	10.1	9.8	9.5	9.2	8.9	8.6	8.4	65 0
70 0	12.5	12.0	11.6	11.2	10.8	10.5	10.2	9.9	9.6	9.3	9.0	8.7	8.5	70 0
75 0	12.6	12.1	11.7	11.3	10.9	10.6	10.3	10.0	9.7	9.4	9.1	8.8	8.6	75 0
80 0	12.7	12.2	11.8	11.4	11.0	10.7	10.4	10.1	9.8	9.5	9.2	8.9	8.7	80 0
85 0	12.7	12.2	11.8	11.4	11.0	10.7	10.4	10.1	9.8	9.5	9.2	8.9	8.7	85 0
90 0	12.8	12.3	11.9	11.5	11.1	10.8	10.5	10.2	9.9	9.6	9.3	9.0	8.8	90 0
Distance of	3.6	4.2	4.7	5.2	5.6	6.0	6.3	6.7	7.0	7.3	7.6	7.9	8.1	Sea Horizon

Additional Correction for Variation of Sun's Semidiameter	Jan. 1	Feb. 1	Mar. 1	April 1	May 1	June 1	July 1	Aug. 1	Sept. 1	Oct. 1	Nov. 1	Dec. 1
	+0′.3	+0′.3	+0′.2	0	−0′.1	−0′.2	−0′.2	−0′.2	−0′.1	0	+0′.1	+0′.3

Additional Correction to be *subtracted from* Correction given for 15m	16m	17m	18m	19m	20m	21m	22m	23m	24m	25m	26m	27m
	52′	56′	59′	62′	66′	69′	72′	76′	79′	82′	85′	89′
	−0′.2	−0′.4	−0′.6	−0′.8	−1′.0	−1′.2	−1′.4	−1′.6	−1′.8	−1′.9	−2′.0	−2′.1

⊙ Total correction of the observed altitude of the Sun's upper limb.

Sun's Altitude	Height of the eye above the sea in metres and feet. [Correction to be *subtracted from* the observed altitude of Sun's upper limb.]													Sun's Altitude
	3m	4m	5m	6m	7m	8m	9m	10m	11m	12m	13m	14m	15m	
	10′	13′	16′	20′	23′	26′	30′	33′	36′	39′	43′	46′	49′	
8° 0′	25.6	26.1	26.5	26.9	27.3	27.6	27.9	28.2	28.5	28.8	29.1	29.4	29.6	8° 0′
10	25.5	26.0	26.4	26.8	27.2	27.5	27.8	28.1	28.4	28.7	29.0	29.3	29.5	10
20	25.4	25.9	26.3	26.7	27.1	27.4	27.7	28.0	28.3	28.6	28.9	29.2	29.4	20
30	25.3	25.8	26.2	26.6	27.0	27.3	27.6	27.9	28.2	28.5	28.8	29.1	29.3	30
40	25.1	25.6	26.0	26.4	26.8	27.1	27.4	27.7	28.0	28.3	28.6	28.9	29.1	40
50	25.0	25.5	25.9	26.3	26.7	27.0	27.3	27.6	27.9	28.2	28.5	28.8	29.0	50
9 0	24.9	25.4	25.8	26.2	26.6	26.9	27.2	27.5	27.8	28.1	28.4	28.7	28.9	9 0
20	24.7	25.2	25.6	26.0	26.4	26.7	27.0	27.3	27.6	27.9	28.2	28.5	28.7	20
40	24.5	25.0	25.4	25.8	26.2	26.5	26.8	27.1	27.4	27.7	28.0	28.3	28.5	40
10 0	24.4	24.9	25.3	25.7	26.1	26.4	26.7	27.0	27.3	27.6	27.9	28.2	28.4	10 0
20	24.2	24.7	25.1	25.5	25.9	26.2	26.5	26.8	27.1	27.4	27.7	28.0	28.2	20
40	24.0	24.5	24.9	25.3	25.7	26.0	26.3	26.6	26.9	27.2	27.5	27.8	28.0	40
11 0	23.9	24.4	24.8	25.2	25.6	25.9	26.2	26.5	26.8	27.1	27.4	27.7	27.9	11 0
30	23.7	24.2	24.6	25.0	25.4	25.7	26.0	26.3	26.6	26.9	27.2	27.5	27.7	30
12 0	23.5	24.0	24.4	24.8	25.2	25.5	25.8	26.1	26.4	26.7	27.0	27.3	27.5	12 0
30	23.3	23.8	24.2	24.6	25.0	25.3	25.6	25.9	26.2	26.5	26.8	27.1	27.3	30
13 0	23.2	23.7	24.1	24.5	24.9	25.2	25.5	25.8	26.1	26.4	26.7	27.0	27.2	13 0
30	23.0	23.5	23.9	24.3	24.7	25.0	25.3	25.6	25.9	26.2	26.5	26.8	27.0	30
14 0	22.9	23.4	23.8	24.2	24.6	24.9	25.2	25.5	25.8	26.1	26.4	26.7	26.9	14 0
30	22.8	23.3	23.7	24.1	24.5	24.8	25.1	25.4	25.7	26.0	26.3	26.6	26.8	30
15 0	22.7	23.2	23.6	24.0	24.4	24.7	25.0	25.3	25.6	25.9	26.2	26.5	26.7	15 0
30	22.6	23.1	23.5	23.9	24.3	24.6	24.9	25.2	25.5	25.8	26.1	26.4	26.6	30
16 0	22.4	22.9	23.3	23.7	24.1	24.4	24.7	25.0	25.3	25.6	25.9	26.2	26.4	16 0
17 0	22.2	22.7	23.1	23.5	23.9	24.2	24.5	24.8	25.1	25.4	25.7	26.0	26.2	17 0
18 0	22.0	22.5	22.9	23.3	23.7	24.0	24.3	24.6	24.9	25.2	25.5	25.8	26.0	18 0
19 0	21.8	22.3	22.7	23.1	23.5	23.8	24.1	24.4	24.7	25.0	25.3	25.6	25.8	19 0
20 0	21.7	22.2	22.6	23.0	23.4	23.7	24.0	24.3	24.6	24.9	25.2	25.5	25.7	20 0
22 0	21.5	22.0	22.4	22.8	23.2	23.5	23.8	24.1	24.4	24.7	25.0	25.3	25.5	22 0
24 0	21.3	21.8	22.2	22.6	23.0	23.3	23.6	23.9	24.2	24.5	24.8	25.1	25.3	24 0
26 0	21.1	21.6	22.0	22.4	22.8	23.1	23.4	23.7	24.0	24.3	24.6	24.9	25.1	26 0
28 0	20.9	21.4	21.8	22.2	22.6	22.9	23.2	23.5	23.8	24.1	24.4	24.7	24.9	28 0
30 0	20.7	21.2	21.6	22.0	22.4	22.7	23.0	23.3	23.6	23.9	24.2	24.5	24.7	30 0
32 0	20.6	21.1	21.5	21.9	22.3	22.6	22.9	23.2	23.5	23.8	24.1	24.4	24.6	32 0
34 0	20.5	21.0	21.4	21.8	22.2	22.5	22.8	23.1	23.4	23.7	24.0	24.3	24.5	34 0
36 0	20.4	20.9	21.3	21.7	22.1	22.4	22.7	23.0	23.3	23.6	23.9	24.2	24.4	36 0
38 0	20.3	20.8	21.2	21.6	22.0	22.3	22.6	22.9	23.2	23.5	23.8	24.1	24.3	38 0
40 0	20.2	20.7	21.1	21.5	21.9	22.2	22.5	22.8	23.1	23.4	23.7	24.0	24.2	40 0
45 0	20.1	20.6	21.0	21.4	21.8	22.1	22.4	22.7	23.0	23.3	23.6	23.9	24.1	45 0
50 0	19.9	20.4	20.8	21.2	21.6	21.9	22.2	22.5	22.8	23.1	23.4	23.7	23.9	50 0
55 0	19.8	20.3	20.7	21.1	21.5	21.8	22.1	22.4	22.7	23.0	23.3	23.6	23.8	55 0
60 0	19.7	20.2	20.6	21.0	21.4	21.7	22.0	22.3	22.6	22.9	23.2	23.5	23.7	60 0
65 0	19.6	20.1	20.5	20.9	21.3	21.6	21.9	22.2	22.5	22.8	23.1	23.4	23.6	65 0
70 0	19.5	20.0	20.4	20.8	21.2	21.5	21.8	22.1	22.4	22.7	23.0	23.3	23.5	70 0
75 0	19.4	19.9	20.3	20.7	21.1	21.4	21.7	22.0	22.3	22.6	22.9	23.2	23.4	75 0
80 0	19.3	19.8	20.2	20.6	21.0	21.3	21.6	21.9	22.2	22.5	22.8	23.1	23.3	80 0
85 0	19.3	19.8	20.2	20.6	21.0	21.3	21.6	21.9	22.2	22.5	22.8	23.1	23.3	85 0
90 0	19.2	19.7	20.1	20.5	20.9	21.2	21.5	21.8	22.1	22.4	22.7	23.0	23.2	90 0
Distance of	3.6	4.2	4.7	5.2	5.6	6.0	6.3	6.7	7.0	7.3	7.6	7.9	8.1	Sea Horizon

Additional Correction for Variation of Sun's Semidiameter	Jan. 1	Feb. 1	Mar. 1	April 1	May 1	June 1	July 1	Aug. 1	Sept. 1	Oct. 1	Nov. 1	Dec. 1
	−0′.3	−0′.3	−0′.2	0	+0′.1	+0′.2	+0′.2	+0′.2	+0′.1	0	−0′.1	−0′.3

Additional Correction to be *added to* Correction given for 15m	16m	17m	18m	19m	20m	21m	22m	23m	24m	25m	26m	27m
	52′	56′	59′	62′	66′	69′	72′	76′	79′	82′	85′	89′
	+0′.2	+0′.4	+0′.6	+0′.8	+1′.0	+1′.2	+1′.4	+1′.6	+1′.8	+1.′9	+2′.0	+2′.1

☾ Total correction of the observed altitude of the Moon's lower limb.

Height of the eye above the sea: 6 metres (20 feet).
[Correction to be *added to* the observed altitude of Moon's lower limb.]

Horizontal Semidiameter from *Nautical Almanac*.

Moon's Altitude	14′		15′						16′						Moon's Altitude
	40″	50″	0″	10″	20″	30″	40″	50″	0″	10″	20″	30″	40″	50″	
8°	57.0	57.8	58.6	59.3	60.1	60.9	61.7	62.4	63.2	64.0	64.7	65.5	66.3	67.1	8°
9	57.6	58.3	59.1	59.8	60.6	61.4	62.2	62.9	63.7	64.5	65.3	66.1	66.8	67.6	9
10	58.0	58.8	59.5	60.3	61.0	61.8	62.6	63.3	64.1	64.9	65.6	66.4	67.2	68.0	10
11	58.3	59.0	59.8	60.6	61.3	62.1	62.9	63.6	64.3	65.2	65.9	66.7	67.5	68.2	11
12	58.5	59.3	60.0	60.8	61.5	62.3	63.1	63.8	64.6	65.4	66.1	66.9	67.7	68.4	12
13	58.6	59.4	60.1	60.9	61.6	62.4	63.2	63.9	64.7	65.5	66.2	67.0	67.8	68.5	13
14	58.7	59.5	60.2	61.0	61.7	62.5	63.3	64.0	64.8	65.6	66.3	67.0	67.8	68.6	14
15	58.7	59.5	60.2	61.0	61.7	62.5	63.3	64.0	64.8	65.5	66.3	67.1	67.8	68.6	15
16	58.7	59.5	60.2	61.0	61.7	62.5	63.2	64.0	64.7	65.5	66.2	67.0	67.7	68.5	16
17	58.6	59.4	60.1	60.9	61.6	62.4	63.1	63.9	64.6	65.4	66.1	66.9	67.6	68.4	17
18	58.5	59.3	60.0	60.8	61.5	62.3	63.0	63.8	64.5	65.3	66.0	66.8	67.5	68.2	18
19	58.4	59.1	59.9	60.6	61.3	62.1	62.9	63.6	64.4	65.1	65.8	66.6	67.3	68.1	19
20	58.2	59.0	59.7	60.5	61.2	61.9	62.7	63.4	64.2	64.9	65.6	66.4	67.1	67.9	20
21	58.0	58.8	59.5	60.3	61.0	61.7	62.5	63.2	63.9	64.7	65.4	66.1	66.9	67.6	21
22	57.8	58.6	59.3	60.0	60.7	61.5	62.2	63.0	63.7	64.4	65.1	65.9	66.6	67.4	22
23	57.6	58.3	59.0	59.7	60.5	61.2	61.9	62.7	63.4	64.1	64.8	65.6	66.3	67.0	23
24	57.3	58.0	58.7	59.5	60.2	60.9	61.6	62.4	63.1	63.8	64.5	65.3	66.0	66.7	24
25	57.0	57.7	58.4	59.2	59.9	60.6	61.3	62.0	62.8	63.5	64.2	64.9	65.7	66.4	25
26	56.7	57.4	58.1	58.9	59.6	60.3	61.0	61.7	62.4	63.2	63.9	64.6	65.3	66.0	26
27	56.4	57.1	57.8	58.5	59.2	59.9	60.6	61.3	62.0	62.8	63.5	64.2	64.9	65.6	27
28	56.0	56.7	57.4	58.1	58.8	59.6	60.3	61.0	61.7	62.4	63.1	63.8	64.5	65.2	28
29	55.6	56.3	57.0	57.7	58.4	59.1	59.8	60.5	61.2	61.9	62.6	63.4	64.0	64.7	29
30	55.2	55.9	56.6	57.3	58.0	58.7	59.4	60.1	60.8	61.5	62.2	62.9	63.6	64.3	30
31	54.8	55.5	56.2	56.9	57.6	58.3	59.0	59.6	60.3	61.0	61.7	62.4	63.1	63.8	31
32	54.4	55.1	55.8	56.5	57.1	57.8	58.5	59.2	59.9	60.6	61.3	61.9	62.6	63.3	32
33	54.0	54.6	55.3	56.0	56.7	57.4	58.0	58.7	59.4	60.1	60.7	61.4	62.1	62.8	33
34	53.5	54.2	54.8	55.5	56.2	56.9	57.5	58.2	58.9	59.6	60.2	60.9	61.6	62.2	34
35	53.0	53.7	54.4	55.0	55.7	56.4	57.0	57.7	58.4	59.0	59.7	60.4	61.0	61.7	35
36	52.5	53.2	53.9	54.5	55.1	55.8	56.5	57.2	57.8	58.5	59.1	59.8	60.5	61.1	36
37	52.0	52.6	53.3	54.0	54.6	55.3	55.9	56.6	57.3	57.9	58.6	59.2	59.9	60.5	37
38	51.5	52.1	52.8	53.4	54.1	54.7	55.4	56.0	56.7	57.3	58.0	58.6	59.3	59.9	38
39	51.0	51.6	52.2	52.9	53.5	54.2	54.8	55.4	56.1	56.7	57.4	58.0	58.7	59.3	39
40	50.4	51.0	51.7	52.3	52.9	53.6	54.2	54.8	55.5	56.1	56.8	57.4	58.0	58.7	40
41	49.8	50.4	51.1	51.7	52.3	53.0	53.6	54.2	54.8	55.5	56.1	56.7	57.4	58.0	41
42	49.2	49.9	50.5	51.1	51.7	52.4	53.0	53.6	54.2	54.8	55.4	56.1	56.7	57.3	42
43	48.6	49.3	49.9	50.5	51.1	51.7	52.3	52.9	53.5	54.2	54.8	55.4	56.0	56.6	43
44	48.0	48.7	49.3	49.9	50.4	51.1	51.7	52.3	52.9	53.5	54.1	54.7	55.3	55.9	44
45	47.4	48.0	48.6	49.2	49.8	50.4	51.0	51.6	52.2	52.8	53.4	54.0	54.6	55.2	45
46	46.8	47.4	48.0	48.6	49.1	49.8	50.3	50.9	51.5	52.1	52.7	53.3	53.9	54.5	46
47	46.1	46.7	47.3	47.9	48.5	49.1	49.6	50.2	50.8	51.4	52.0	52.6	53.1	53.7	47
48	45.5	46.1	46.6	47.2	47.8	48.4	48.9	49.5	50.1	50.7	51.2	51.8	52.4	53.0	48
49	44.8	45.4	45.9	46.5	47.1	47.6	48.2	48.8	49.3	49.9	50.5	51.1	51.6	52.2	49

Height of eye	3m	4m	5m	7m	8m	9m	10m	11m	12m	13m	14m	15m	16m	17m	18m	19m	20m
	10′	13′	16′	23′	26′	30′	33′	36′	39′	43′	46′	49′	52′	56′	59′	62′	66′
Additional correction	+1.3	+0.8	+0.4	−0.4	−0.7	−1.0	−1.3	−1.6	−1.9	−2.2	−2.5	−2.7	−2.9	−3.1	−3.3	−3.5	−3.7

Observation. For ☾ *subtract* the Moon's Diameter *from* values given for ☾.

☾ Total correction of the observed altitude of the Moon's lower limb.

Height of the eye above the sea: 6 metres (20 feet).
[Correction to be *added to* the observed altitude of Moon's lower limb.]

Horizontal Semidiameter from *Nautical Almanac*.

Moon's Altitude.	14′		15′						16′						Moon's Altitude.
	40″	50″	0″	10″	20″	30″	40″	50″	0″	10″	20″	30″	40″	50″	
49°	44.8	45.4	45.9	46.5	47.1	47.6	48.2	48.8	49.3	49.9	50.5	51.1	51.6	52.2	49°
50	44.1	44.7	45.3	45.8	46.4	46.9	47.5	48.0	48.6	49.2	49.7	50.3	50.9	51.4	50
51	43.4	44.0	44.5	45.1	45.6	46.2	46.7	47.3	47.8	48.4	48.9	49.5	50.0	50.6	51
52	42.7	43.3	43.8	44.3	44.9	45.5	46.0	46.5	47.1	47.6	48.1	48.7	49.2	49.8	52
53	42.0	42.5	43.1	43.6	44.1	44.7	45.2	45.7	46.3	46.8	47.3	47.9	48.4	48.9	53
54	41.3	41.8	42.3	42.8	43.4	43.9	44.4	44.9	45.5	46.0	46.5	47.1	47.6	48.1	54
55	40.5	41.0	41.6	42.1	42.6	43.1	43.6	44.1	44.7	45.2	45.7	46.2	46.7	47.3	55
56	39.8	40.3	40.8	41.3	41.8	42.3	42.8	43.3	43.9	44.4	44.9	45.4	45.9	46.4	56
57	39.0	39.5	40.0	40.5	41.0	41.5	42.0	42.5	43.0	43.5	44.0	44.5	45.0	45.5	57
58	38.3	38.8	39.2	39.7	40.2	40.7	41.2	41.7	42.2	42.7	43.2	43.7	44.2	44.6	58
59	37.5	38.0	38.4	38.9	39.4	39.9	40.4	40.8	41.3	41.8	42.3	42.8	43.3	43.7	59
60	36.7	37.2	37.6	38.1	38.6	39.1	39.5	40.0	40.5	41.0	41.4	41.9	42.4	42.8	60
61	35.9	36.4	36.8	37.3	37.8	38.2	38.7	39.1	39.6	40.1	40.5	41.0	41.5	41.9	61
62	35.1	35.6	36.0	36.5	36.9	37.4	37.8	38.3	38.7	39.2	39.6	40.1	40.6	41.0	62
63	34.3	34.7	35.2	35.6	36.1	36.5	37.0	37.4	37.8	38.3	38.7	39.2	39.6	40.1	63
64	33.5	33.9	34.3	34.8	35.2	35.7	36.1	36.5	37.0	37.4	37.8	38.3	38.7	39.1	64
65	32.7	33.1	33.5	33.9	34.4	34.8	35.2	35.6	36.1	36.5	36.9	37.3	37.8	38.2	65
66	31.8	32.2	32.6	33.1	33.5	33.9	34.3	34.7	35.1	35.6	36.0	36.4	36.8	37.2	66
67	31.0	31.4	31.8	32.2	32.6	33.0	33.4	33.8	34.2	34.6	35.0	35.5	35.9	36.3	67
68	30.2	30.5	30.9	31.3	31.7	32.1	32.5	32.9	33.3	33.7	34.1	34.5	34.9	35.3	68
69	29.3	29.7	30.1	30.4	30.8	31.2	31.6	32.0	32.4	32.8	33.2	33.5	33.9	34.3	69
70	28.4	28.8	29.2	29.6	29.9	30.3	30.7	31.0	31.4	31.8	32.2	32.6	32.9	33.3	70
71	27.5	27.9	28.3	28.6	29.0	29.4	29.7	30.1	30.5	30.9	31.2	31.6	31.9	32.3	71
72	26.7	27.0	27.4	27.7	28.1	28.5	28.8	29.2	29.5	29.9	30.2	30.6	30.9	31.3	72
73	25.8	26.1	26.5	26.8	27.2	27.5	27.9	28.2	28.6	28.9	29.3	29.6	29.9	30.3	73
74	24.9	25.3	25.6	25.9	26.3	26.6	26.9	27.3	27.6	27.9	28.3	28.6	28.9	29.3	74
75	24.0	24.4	24.7	25.0	25.3	25.7	26.0	26.3	26.6	27.0	27.3	27.6	27.9	28.3	75
76	23.1	23.5	23.8	24.1	24.4	24.7	25.0	25.3	25.7	26.0	26.3	26.6	26.9	27.2	76
77	22.3	22.6	22.9	23.2	23.5	23.8	24.1	24.4	24.7	25.0	25.3	25.6	25.9	26.2	77
78	21.4	21.7	21.9	22.2	22.5	22.8	23.1	23.4	23.7	24.0	24.3	24.6	24.9	25.2	78
79	20.4	20.7	21.0	21.3	21.6	21.9	22.1	22.4	22.7	23.0	23.3	23.6	23.9	24.1	79
80	19.5	19.8	20.1	20.4	20.6	20.9	21.2	21.5	21.7	22.0	22.3	22.6	22.8	23.1	80
81	18.6	18.9	19.2	19.4	19.7	20.0	20.2	20.5	20.7	21.0	21.3	21.5	21.8	22.1	81
82	17.7	18.0	18.2	18.5	18.7	19.0	19.3	19.5	19.8	20.0	20.3	20.5	20.8	21.0	82
83	16.8	17.0	17.3	17.5	17.8	18.0	18.3	18.5	18.8	19.0	19.2	19.5	19.7	20.0	83
84	15.9	16.1	16.4	16.6	16.8	17.1	17.3	17.5	17.8	18.0	18.2	18.5	18.7	18.9	84
85	15.0	15.2	15.4	15.6	15.9	16.1	16.3	16.5	16.8	17.0	17.2	17.4	17.6	17.9	85
86	14.1	14.3	14.5	14.7	14.9	15.1	15.3	15.5	15.8	16.0	16.2	16.4	16.6	16.8	86
87	13.1	13.3	13.5	13.7	13.9	14.2	14.3	14.5	14.7	14.9	15.1	15.3	15.5	15.7	87
88	12.2	12.4	12.6	12.8	13.0	13.2	13.4	13.5	13.7	13.9	14.1	14.3	14.5	14.7	88
89	11.3	11.5	11.7	11.8	12.0	12.2	12.4	12.6	12.7	12.9	13.1	13.3	13.4	13.6	89
90	10.4	10.5	10.7	10.9	11.1	11.2	11.4	11.6	11.7	11.9	12.1	12.2	12.4	12.6	90

Height of eye	3m	4m	5m	7m	8m	9m	10m	11m	12m	13m	14m	15m	16m	17m	18m	19m	20m
	10′	13′	16′	23′	26′	30′	33′	36′	39′	43′	46′	49′	52′	56′	59′	62′	66′
Additional correction	+1.3	+0.8	+0.4	−0.4	−0.7	−1.0	−1.3	−1.6	−1.9	−2.2	−2.5	−2.7	−2.9	−3.1	−3.3	−3.5	−3.7

Observation. For ☾ *subtract* the Moon's Diameter *from* values given for ☾.

$\frac{60'}{\Delta}$	Number of Minutes of b															$\frac{\Delta}{60'}$
	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′	11′	12′	13′	14′	15′	
	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	
1.00	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	1.00
1.02	1.0	2.0	3.0	4.0	5.0	5.9	6.9	7.9	8.9	9.8	10.8	11.8	12.8	13.8	14.7	0.98
1.03	1.0	2.0	2.9	3.9	4.9	5.8	6.8	7.7	8.7	9.7	10.6	11.6	12.6	13.5	14.5	.97
1.05	1.0	1.9	2.9	3.8	4.8	5.7	6.7	7.6	8.6	9.5	10.5	11.4	12.3	13.3	14.2	.95
1.07	0.9	1.9	2.8	3.8	4.7	5.6	6.6	7.4	8.4	9.3	10.3	11.2	12.1	13.1	14.0	.93
1.09	0.9	1.9	2.8	3.7	4.6	5.5	6.5	7.3	8.3	9.2	10.1	11.0	11.9	12.8	13.7	0.92
1.11	.9	1.8	2.7	3.6	4.5	5.4	6.3	7.2	8.1	9.0	9.9	10.8	11.7	12.6	13.5	.90
1.13	.9	1.8	2.7	3.6	4.5	5.3	6.2	7.1	8.0	8.8	9.7	10.6	11.5	12.4	13.2	.88
1.15	.9	1.8	2.6	3.5	4.4	5.2	6.1	6.9	7.8	8.7	9.5	10.4	11.2	12.1	13.0	.87
1.18	.8	1.7	2.6	3.4	4.3	5.1	6.0	6.8	7.7	8.5	9.4	10.2	11.0	11.9	12.7	.85
1.20	0.8	1.7	2.5	3.4	4.2	5.0	5.9	6.7	7.5	8.3	9.2	10.0	10.8	11.7	12.5	0.83
1.22	.8	1.6	2.5	3.3	4.1	4.9	5.7	6.5	7.4	8.2	9.0	9.8	10.6	11.4	12.2	.82
1.25	.8	1.6	2.4	3.2	4.0	4.8	5.6	6.4	7.2	8.0	8.8	9.6	10.4	11.2	12.0	.80
1.28	.8	1.6	2.4	3.2	4.0	4.7	5.5	6.3	7.1	7.8	8.6	9.4	10.2	11.0	11.7	.78
1.30	.8	1.6	2.3	3.1	3.9	4.6	5.4	6.1	6.9	7.7	8.4	9.2	10.0	10.7	11.5	.77
1.33	0.8	1.5	2.3	3.0	3.8	4.5	5.3	6.0	6.8	7.5	8.3	9.0	9.7	10.5	11.2	0.75
1.36	.7	1.5	2.2	3.0	3.7	4.4	5.2	5.9	6.6	7.3	8.1	8.8	9.5	10.3	11.0	.73
1.40	.7	1.4	2.2	2.9	3.6	4.3	5.0	5.7	6.5	7.2	7.9	8.6	9.3	10.0	10.7	.72
1.43	.7	1.4	2.1	2.8	3.5	4.2	4.9	5.6	6.3	7.0	7.7	8.4	9.1	9.8	10.5	.70
1.46	.7	1.4	2.1	2.8	3.5	4.1	4.8	5.5	6.2	6.8	7.5	8.2	8.9	9.6	10.2	.68
1.50	0.7	1.3	2.0	2.7	3.4	4.0	4.7	5.3	6.0	6.7	7.3	8.0	8.7	9.3	10.0	0.67
1.54	.7	1.3	2.0	2.6	3.3	3.9	4.6	5.2	5.9	6.5	7.2	7.8	8.4	9.1	9.7	.65
1.58	.6	1.3	1.9	2.6	3.2	3.8	4.5	5.1	5.7	6.3	7.0	7.6	8.2	8.9	9.5	.63
1.62	.6	1.2	1.9	2.5	3.1	3.7	4.3	4.9	5.6	6.2	6.8	7.4	8.0	8.6	9.2	.62
1.67	.6	1.2	1.8	2.4	3.0	3.6	4.2	4.8	5.4	6.0	6.6	7.2	7.8	8.4	9.0	.60
1.71	0.6	1.2	1.8	2.4	2.9	3.5	4.1	4.7	5.3	5.8	6.4	7.0	7.6	8.2	8.7	0.58
1.76	.6	1.1	1.7	2.3	2.9	3.4	4.0	4.5	5.1	5.7	6.2	6.8	7.4	7.9	8.5	.57
1.82	.6	1.1	1.7	2.2	2.8	3.3	3.9	4.4	5.0	5.5	6.1	6.6	7.1	7.7	8.2	.55
1.88	.5	1.1	1.6	2.2	2.7	3.2	3.8	4.3	4.8	5.3	5.9	6.4	6.9	7.5	8.0	.53
1.94	.5	1.0	1.6	2.1	2.6	3.1	3.6	4.1	4.7	5.2	5.7	6.2	6.7	7.2	7.7	.52
2.00	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	0.50
2.07	.5	1.0	1.5	1.9	2.4	2.9	3.4	3.9	4.4	4.8	5.3	5.8	6.3	6.8	7.2	.48
2.14	.5	0.9	1.4	1.9	2.4	2.8	3.3	3.7	4.2	4.7	5.1	5.6	6.1	6.5	7.0	.47
2.22	.5	.9	1.4	1.8	2.3	2.7	3.2	3.6	4.1	4.5	5.0	5.4	5.8	6.3	6.7	.45
2.31	.4	.9	1.3	1.7	2.2	2.6	3.1	3.5	3.9	4.3	4.8	5.2	5.6	6.1	6.5	.43
2.40	0.4	0.8	1.3	1.7	2.1	2.5	2.9	3.3	3.8	4.2	4.6	5.0	5.4	5.8	6.2	0.42
2.50	.4	.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0	4.4	4.8	5.2	5.6	6.0	.40
2.61	.4	.8	1.2	1.5	1.9	2.3	2.7	3.1	3.5	3.8	4.2	4.6	5.0	5.4	5.7	.38
2.73	.4	.7	1.1	1.5	1.9	2.2	2.6	2.9	3.3	3.7	4.0	4.4	4.8	5.1	5.5	.37
2.86	.4	.7	1.1	1.4	1.8	2.1	2.5	2.8	3.2	3.5	3.9	4.2	4.5	4.9	5.2	.35
3.00	0.3	0.7	1.0	1.3	1.7	2.0	2.3	2.7	3.0	3.3	3.7	4.0	4.3	4.7	5.0	0.33
3.16	.3	.6	1.0	1.3	1.6	1.9	2.2	2.5	2.9	3.2	3.5	3.8	4.1	4.4	4.7	.32
3.33	.3	.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.0	3.3	3.6	3.9	4.2	4.5	.30
3.53	.3	.6	.9	1.1	1.4	1.7	2.0	2.3	2.6	2.8	3.1	3.4	3.7	4.0	4.2	.28
3.75	.3	.5	.8	1.1	1.3	1.6	1.9	2.1	2.4	2.7	2.9	3.2	3.5	3.7	4.0	.27
4.00	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.0	2.3	2.5	2.8	3.0	3.2	3.5	3.7	0.25
4.29	.2	.5	.7	0.9	1.2	1.4	1.6	1.9	2.1	2.3	2.6	2.8	3.0	3.3	3.5	.23
4.62	.2	.4	.7	.9	1.1	1.3	1.5	1.7	2.0	2.2	2.4	2.6	2.8	3.0	3.2	.22
5.00	.2	.4	.6	.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	.20
5.45	.2	.4	.6	.7	0.9	1.1	1.3	1.5	1.7	1.8	2.0	2.2	2.4	2.6	2.7	.18
6.00	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.5	1.7	1.8	2.0	2.2	2.3	2.5	0.17
6.67	.2	.3	.5	.6	.8	0.9	1.1	1.2	1.4	1.5	1.7	1.8	2.0	2.1	2.2	.15
7.50	.1	.3	.4	.5	.7	.8	0.9	1.1	1.2	1.3	1.5	1.6	1.7	1.9	2.0	.13
8.57	.1	.2	.4	.5	.6	.7	.8	0.9	1.1	1.2	1.3	1.4	1.5	1.6	1.7	.12
10.0	.1	.2	.3	.4	.5	.6	.7	.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	.10
12.0	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8	0.8	0.9	1.0	1.1	1.2	1.2	0.08
15.0	.1	.1	.2	.3	.3	.4	.5	.5	.6	.7	.7	0.8	0.9	0.9	1.0	.07
20.0	.1	.1	.2	.2	.3	.3	.4	.4	.5	.5	.6	.6	.6	.7	0.7	.05
30.0	.0	.1	.1	.1	.2	.2	.2	.3	.3	.3	.4	.4	.4	.5	.5	.03
60.0	.0	.0	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.02

$\frac{60'}{\Delta}$	Number of Minutes of b														$\frac{\Delta}{60'}$
	16′	17′	18′	19′	20′	21′	22′	23′	24′	25′	26′	27′	28′	29′	30′	
	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	
1.00	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25.0	26.0	27.0	28.0	29.0	30.0	1.00
1.02	15.7	16.7	17.7	18.7	19.7	20.7	21.6	22.6	23.6	24.6	25.6	26.6	27.5	28.5	29.5	0.98
1.03	15.5	16.5	17.4	18.4	19.3	20.3	21.3	22.2	23.2	24.2	25.1	26.1	27.1	28.0	29.0	.97
1.05	15.2	16.2	17.1	18.1	19.0	20.0	20.9	21.9	22.8	23.8	24.7	25.7	26.6	27.6	28.5	.95
1.07	14.9	15.9	16.8	17.7	18.7	19.6	20.5	21.5	22.4	23.3	24.3	25.2	26.1	27.1	28.0	.93
1.09	14.7	15.6	16.5	17.4	18.3	19.3	20.2	21.1	22.0	22.9	23.8	24.8	25.7	26.6	27.5	0.92
1.11	14.4	15.3	16.2	17.1	18.0	18.9	19.8	20.7	21.6	22.5	23.4	24.3	25.2	26.1	27.0	.90
1.13	14.1	15.0	15.9	16.8	17.7	18.6	19.4	20.3	21.2	22.1	23.0	23.9	24.7	25.6	26.5	.88
1.15	13.9	14.8	15.6	16.5	17.3	18.2	19.1	19.9	20.8	21.7	22.5	23.4	24.3	25.1	26.0	.87
1.18	13.6	14.5	15.3	16.2	17.0	17.9	18.7	19.6	20.4	21.3	22.1	23.0	23.8	24.7	25.5	.85
1.20	13.3	14.2	15.0	15.8	16.7	17.5	18.3	19.2	20.0	20.8	21.7	22.5	23.3	24.2	25.0	0.83
1.22	13.1	13.9	14.7	15.5	16.3	17.2	18.0	18.8	19 6	20.4	21.2	22.1	22.9	23.7	24.5	.82
1.25	12.8	13.6	14.4	15.2	16.0	16.8	17.6	18.4	19.2	20.0	20.8	21.6	22.4	23.2	24.0	.80
1.28	12.5	13.3	14.1	14.9	15.7	16.5	17.2	18.0	18.8	19.6	20.4	21.2	21.9	22.7	23.5	.78
1.30	12.3	13.0	13.8	14.6	15.3	16.1	16.9	17.6	18.4	19.2	19.9	20.7	21.5	22.2	23.0	.77
1.33	12.0	12.8	13.5	14.3	15.0	15.8	16.5	17.3	18.0	18.8	19.5	20.3	21.0	21.8	22.5	0.75
1.36	11.7	12.5	13.2	13.9	14.7	15.4	16.1	16.9	17.6	18.3	19.1	19.8	20.5	21.3	22.0	.73
1.40	11.5	12.2	12.9	13.6	14.3	15.1	15.8	16.5	17.2	17.9	18.6	19.4	20.1	20.8	21.5	.72
1.43	11.2	11.9	12.6	13.3	14.0	14.7	15.4	16.1	16.8	17.5	18.2	18.9	19.6	20.3	21.0	.70
1.46	10.9	11.6	12.3	13.0	13.7	14.4	15.0	15.7	16.4	17.1	17.8	18.5	19.1	19.8	20.5	.68
1.50	10.7	11.3	12.0	12.7	13.3	14.0	14.7	15.3	16.0	16.7	17.3	18.0	18.7	19.3	20.0	0.67
1.54	10.4	11.1	11.7	12.4	13.0	13.7	14.3	15.0	15.6	16.3	16.9	17.6	18.2	18.9	19.5	.65
1.58	10.1	10.8	11.4	12.0	12.7	13.3	13.9	14.6	15.2	15.8	16.5	17.1	17.7	18.4	19.0	.63
1.62	9.9	10.5	11.1	11.7	12.3	13.0	13.6	14.2	14.8	15.4	16.0	16.7	17.3	17.9	18.5	.62
1.67	9.6	10.2	10.8	11.4	12.0	12.6	13.2	13.8	14.4	15.0	15.6	16.2	16.8	17.4	18.0	.60
1.71	9.3	9.9	10.5	11.1	11.7	12.3	12.8	13.4	14.0	14.6	15.2	15.8	16.3	16.9	17.5	0.58
1.76	9.1	9.6	10.2	10.8	11.3	11.9	12.5	13.0	13.6	14.2	14.7	15.3	15.9	16.4	17.0	.57
1.82	8.8	9.4	9.9	10.5	11.0	11.6	12.1	12.7	13.2	13.8	14.3	14.9	15.4	16.0	16.5	.55
1.88	8.5	9.1	9.6	10.1	10.7	11.2	11.7	12.3	12.8	13.3	13.9	14.4	14.9	15.5	16.0	.53
1.94	8.3	8.8	9.3	9.8	10.3	10.9	11.4	11.9	12.4	12.9	13.4	14.0	14.5	15.0	15.5	.52
2.00	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	0.50
2.07	7.7	8.2	8.7	9.2	9.7	10.2	10.6	11.1	11.6	12.1	12.6	13.1	13.5	14.0	14.5	.48
2.14	7.5	7.9	8.4	8.9	9.3	9.8	10.3	10.7	11.2	11.7	12.1	12.6	13.1	13.5	14.0	.47
2.22	7.2	7.7	8.1	8.6	9.0	9.5	9.9	10.4	10.8	11.3	11.7	12.2	12.6	13.1	13.5	.45
2.31	6.9	7.4	7.8	8.2	8.7	9.1	9.5	10.0	10.4	10.8	11.3	11.7	12.1	12.6	13.0	.43
2.40	6.7	7.1	7.5	7.9	8.3	8.8	9.2	9.6	10.0	10.4	10.8	11.3	11.7	12.1	12.5	0.42
2.50	6.4	6.8	7.2	7.6	8.0	8.4	8.8	9.2	9.6	10.0	10.4	10.8	11.2	11.6	12.0	.40
2.61	6.1	6.5	6.9	7.3	7.7	8.1	8.4	8.8	9.2	9.6	10.0	10.4	10.7	11.1	11.5	.38
2.73	5.9	6.2	6.6	7.0	7.3	7.7	8.1	8.4	8.8	9.2	9.5	9.9	10.3	10.6	11.0	.37
2.86	5.6	6.0	6.3	6.7	7.0	7.4	7.7	8.1	8.4	8.8	9.1	9.5	9.8	10.2	10.5	.35
3.00	5.3	5.7	6.0	6.3	6.7	7.0	7.3	7.7	8.0	8.3	8.7	9.0	9.3	9.7	10.0	0.33
3.16	5.1	5.4	5.7	6.0	6.3	6.7	7.0	7.3	7.6	7.9	8.2	8.6	8.9	9.2	9.5	.32
3.33	4.8	5.1	5.4	5.7	6.0	6.3	6.6	6.9	7.2	7.5	7.8	8.1	8.4	8.7	9.0	.30
3.53	4.5	4.8	5.1	5.4	5.7	6.0	6.2	6.5	6.8	7.1	7.4	7.7	7.9	8.2	8.5	.28
3.75	4.3	4.6	4.8	5.1	5.3	5.6	5.9	6.1	6.4	6.7	6.9	7.2	7.5	7.7	8.0	.27
4.00	4.0	4.3	4.5	4.8	5.0	5.3	5.5	5.8	6.0	6.3	6.5	6.8	7.0	7.3	7.5	0.25
4.29	3.7	4.0	4.2	4.4	4.7	4.9	5.1	5.4	5.6	5.8	6.1	6.3	6.5	6.8	7.0	.23
4.62	3.5	3.7	3.9	4.1	4.3	4.6	4.8	5.0	5.2	5.4	5.6	5.9	6.1	6.3	6.5	.22
5.00	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4 8	5.0	5.2	5.4	5.6	5.8	6.0	.20
5.45	2.9	3.1	3.3	3.5	3.7	3.9	4.0	4.2	4.4	4.6	4.8	5.0	5.1	5.3	5.5	.18
6.00	2.7	2.8	3.0	3.2	3.3	3.5	3.7	3.8	4.0	4.2	4.3	4.5	4.7	4.8	5.0	0.17
6.67	2.4	2.6	2.7	2.9	3.0	3.2	3.3	3.5	3.6	3.8	3.9	4.1	4.2	4.4	4.5	.15
7.50	2.1	2.3	2.4	2.5	2.7	2.8	2.9	3.1	3.2	3.3	3.5	3.6	3.7	3.9	4.0	.13
8.57	1.9	2.0	2.1	2.2	2.3	2.5	2.6	2.7	2.8	2.9	3.0	3.2	3.3	3.4	3.5	.12
10.0	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	.10
12.0	1.3	1.4	1.5	1.6	1.7	1.8	1.8	1.9	2.0	2.1	2.2	2.3	2.3	2.4	2.5	0.08
15.0	1.1	1.1	1.2	1.3	1.3	1.4	1.5	1.5	1.6	1.7	1.7	1.8	1.9	1.9	2.0	.07
20.0	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.2	1.2	1.3	1.3	1.4	1.4	1.5	1.5	.05
30.0	.5	.6	.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.9	0.9	0.9	1.0	1.0	.03
60.0	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4	.5	.5	0.5	0.5	.02

60′/Δ	Number of Minutes of *b*														Δ/60′
	31′	32′	33′	34′	35′	36′	37′	38′	39′	40′	41′	42′	43′	44′	45′	
	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	
1.00	31.0	32.0	33.0	34.0	35.0	36.0	37.0	38.0	39.0	40.0	41.0	42.0	43.0	44.0	45.0	1.00
1.02	30.5	31.5	32.5	33.4	34.4	35.4	36.4	37.4	38.4	39.3	40.3	41.3	42.3	43.3	44.3	0.98
1.03	30.0	30.9	31.9	32.9	33.8	34.8	35.8	36.7	37.7	38.7	39.6	40.6	41.6	42.5	43.5	.97
1.05	29.5	30.4	31.4	32.3	33.3	34.2	35.2	36.1	37.1	38.0	39.0	39.9	40.9	41.8	42.8	.95
1.07	28.9	29.9	30.8	31.7	32.7	33.6	34.5	35.5	36.4	37.3	38.3	39.2	40.1	41.1	42.0	.93
1.09	28.4	29.3	30.3	31.2	32.1	33.0	33.9	34.8	35.8	36.7	37.6	38.5	39.4	40.3	41.3	0.92
1.11	27.9	28.8	29.7	30.6	31.5	32.4	33.3	34.2	35.1	36.0	36.9	37.8	38.7	39.6	40.5	.90
1.13	27.4	28.3	29.2	30.0	30.9	31.8	32.7	33.6	34.5	35.3	36.2	37.1	38.0	38.9	39.8	.88
1.15	26.9	27.7	28.6	29.5	30.3	31.2	32.1	32.9	33.8	34.7	35.5	36.4	37.3	38.1	39.0	.87
1.18	26.4	27.2	28.1	28.9	29.8	30.6	31.5	32.3	33.2	34.0	34.9	35.7	36.6	37.4	38.3	.85
1.20	25.8	26.7	27.5	28.3	29.2	30.0	30.8	31.7	32.5	33.3	34.2	35.0	35.8	36.7	37.5	0.83
1.22	25.3	26.1	27.0	27.8	28.6	29.4	30.2	31.0	31.9	32.7	33.5	34.3	35.1	35.9	36.8	.82
1.25	24.8	25.6	26.4	27.2	28.0	28.8	29.6	30.4	31.2	32.0	32.8	33.6	34.4	35.2	36.0	.80
1.28	24.3	25.1	25.9	26.6	27.4	28.2	29.0	29.8	30.6	31.3	32.1	32.9	33.7	34.5	35.3	.78
1.30	23.8	24.5	25.3	26.1	26.8	27.6	28.4	29.1	29.9	30.7	31.4	32.2	33.0	33.7	34.5	.77
1.33	23.3	24.0	24.8	25.5	26.3	27.0	27.8	28.5	29.3	30.0	30.8	31.5	32.3	33.0	33.8	0.75
1.36	22.8	23.5	24.2	24.9	25.7	26.4	27.1	27.9	28.6	29.3	30.1	30.8	31.5	32.3	33.0	.73
1.40	22.3	22.9	23.7	24.4	25.1	25.8	26.5	27.2	28.0	28.7	29.4	30.1	30.8	31.5	32.3	.72
1.43	21.8	22.4	23.1	23.8	24.5	25.2	25.9	26.6	27.3	28.0	28.7	29.4	30.1	30.8	31.5	.70
1.46	21.3	21.9	22.6	23.2	23.9	24.6	25.3	26.0	26.7	27.3	28.0	28.7	29.4	30.1	30.8	.68
1.50	20.7	21.3	22.0	22.7	23.3	24.0	24.7	25.3	26.0	26.7	27.3	28.0	28.7	29.3	30.0	0.67
1.54	20.2	20.8	21.5	22.1	22.8	23.4	24.1	24.7	25.4	26.0	26.7	27.3	28.0	28.6	29.3	.65
1.58	19.6	20.3	20.9	21.5	22.2	22.8	23.4	24.1	24.7	25.3	26.0	26.6	27.2	27.9	28.5	.63
1.62	19.1	19.7	20.4	21.0	21.6	22.2	22.8	23.4	24.1	24.7	25.3	25.9	26.5	27.1	27.8	.62
1.67	18.6	19.2	19.8	20.4	21.0	21.6	22.2	22.8	23.4	24.0	24.6	25.2	25.8	26.4	27.0	60
1.71	18.1	18.7	19.3	19.8	20.4	21.0	21.6	22.2	22.8	23.3	23.9	24.5	25.1	25.7	26.3	0.58
1.76	17.6	18.1	18.7	19.3	19.8	20.4	21.0	21.5	22.1	22.7	23.2	23.8	24.4	24.9	25.5	.57
1.82	17.1	17.6	18.2	18.7	19.3	19.8	20.4	20.9	21.5	22.0	22.6	23.1	23.7	24.2	24.8	.55
1.88	16.5	17.1	17.6	18.1	18.7	19.2	19.7	20.3	20.8	21.3	21.9	22.4	22.9	23.5	24.0	.53
1.94	16.0	16.5	17.1	17.6	18.1	18.6	19.1	19.6	20.2	20.7	21.2	21.7	22.2	22.7	23.3	.52
2.00	15.5	16.0	16.5	17.0	17.5	18.0	18.5	19.0	19.5	20.0	20.5	21.0	21.5	22.0	22.5	0.50
2.07	15.0	15.5	16.0	16.4	16.9	17.4	17.9	18.4	18.9	19.3	19.8	20.3	20.8	21.3	21.8	.48
2.14	14.5	14.9	15.4	15.9	16.3	16.8	17.3	17.7	18.2	18.7	19.1	19.6	20.1	20.5	21.0	.47
2.22	14.0	14.4	14.9	15.3	15.8	16.2	16.7	17.1	17.6	18.0	18.5	18.9	19.4	19.8	20.3	.45
2.31	13.4	13.9	14.3	14.7	15.2	15.6	16.0	16.5	16.9	17.3	17.8	18.2	18.6	19.1	19.5	.43
2.40	12.9	13.3	13.8	14.2	14.6	15.0	15.4	15.8	16.3	16.7	17.1	17.5	17.9	18.3	18.8	0.42
2.50	12.4	12.8	13.2	13.6	14.0	14.4	14.8	15.2	15.6	16.0	16.4	16.8	17.2	17.6	18.0	.40
2.61	11.9	12.3	12.7	13.0	13.4	13.8	14.2	14.6	15.0	15.3	15.7	16.1	16.5	16.9	17.3	.38
2.73	11.4	11.7	12.1	12.5	12.8	13.2	13.6	13.9	14.3	14.7	15.0	15.4	15.8	16.1	16.5	.37
2.86	10.9	11.2	11.6	11.9	12.3	12.6	13.0	13.3	13.7	14.0	14.4	14.7	15.1	15.4	15.8	.35
3.00	10.3	10.7	11.0	11.3	11.7	12.0	12.3	12.7	13.0	13.3	13.7	14.0	14.3	14.7	15.0	0.33
3.16	9.8	10.1	10.5	10.8	11.1	11.4	11.7	12.0	12.4	12.7	13.0	13.3	13.6	13.9	14.3	.32
3.33	9.3	9.6	9.9	10.2	10.5	10.8	11.1	11.4	11.7	12.0	12.3	12.6	12.9	13.2	13.5	.30
3.53	8.8	9.1	9.4	9.6	9.9	10.2	10.5	10.8	11.1	11.3	11.6	11.9	12.2	12.5	12.8	.28
3.75	8.3	8.5	8.8	9.1	9.3	9.6	9.9	10.1	10.4	10.7	10.9	11.2	11.5	11.7	12.0	.27
4.00	7.8	8.0	8.3	8.5	8.8	9.0	9.3	9.5	9.8	10.0	10.3	10.5	10.8	11.0	11.3	0.25
4.29	7.2	7.5	7.7	7.9	8.2	8.4	8.6	8.9	9.1	9.3	9.6	9.8	10.0	10.3	10.5	.23
4.62	6.7	6.9	7.2	7.4	7.6	7.8	8.0	8.2	8.5	8.7	8.9	9.1	9.3	9.5	9.8	.22
5.00	6.2	6.4	6.6	6.8	7.0	7.2	7.4	7.6	7.8	8.0	8.2	8.4	8.6	8.8	9.0	.20
5.45	5.7	5.9	6.1	6.2	6.4	6.6	6.8	7.0	7.2	7.3	7.5	7.7	7.9	8.1	8.3	.18
6.00	5.2	5.3	5.5	5.7	5.8	6.0	6.2	6.3	6.5	6.7	6.8	7.0	7.2	7.3	7.5	0.17
6.67	4.7	4.8	5.0	5.1	5.3	5.4	5.6	5.7	5.9	6.0	6.2	6.3	6.5	6.6	6.8	.15
7.50	4.1	4.3	4.4	4.5	4.7	4.8	4.9	5.1	5.2	5.3	5.5	5.6	5.7	5.9	6.0	.13
8.57	3.6	3.7	3.9	4.0	4.1	4.2	4.3	4.4	4.6	4.7	4.8	4.9	5.0	5.1	5.3	.12
10.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	.10
12.0	2.6	2.7	2.8	2.8	2.9	3.0	3.1	3.2	3.3	3.3	3.4	3.5	3.6	3.7	3.8	0.08
15.0	2.1	2.1	2.2	2.3	2.3	2.4	2.5	2.5	2.6	2.7	2.7	2.8	2.9	2.9	3.0	.07
20.0	1.6	1.6	1.7	1.7	1.8	1.8	1.9	1.9	2.0	2.0	2.1	2.1	2.2	2.2	2.3	.05
30.0	1.0	1.1	1.1	1.1	1.2	1.2	1.2	1.3	1.3	1.3	1.4	1.4	1.4	1.5	1.5	.03
60.0	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.8	.02

60′/Δ	Number of Minutes of *b*														Δ/60′
	46′	47′	48′	49′	50′	51′	52′	53′	54′	55′	56′	57′	58′	59′	60′	
1.00	46.0	47.0	48.0	49.0	50.0	51.0	52.0	53.0	54.0	55.0	56.0	57.0	58.0	59.0	60.0	1.00
1.02	45.2	46.2	47.2	48.2	49.2	50.2	51.1	52.1	53.1	54.1	55.1	56.0	57.0	58.0	59.0	0.98
1.03	44.5	45.4	46.4	47.4	48.3	49.3	50.3	51.2	52.2	53.2	54.1	55.1	56.1	57.0	58.0	.97
1.05	43.7	44.7	45.6	46.6	47.5	48.5	49.4	50.4	51.2	52.3	53.2	54.1	55.1	56.1	57.0	.95
1.07	42.9	43.9	44.8	45.7	46.7	47.6	48.5	49.5	50.4	51.3	52.3	53.2	54.1	55.1	56.0	.93
1.09	42.2	43.1	44.0	44.9	45.8	46.8	47.7	48.6	49.5	50.4	51.3	52.2	53.2	54.1	55.0	0.92
1.11	41.4	42.3	43.2	44.1	45.0	45.9	46.8	47.7	48.6	49.5	50.4	51.3	52.2	53.1	54.0	.90
1.13	40.6	41.5	42.4	43.3	44.2	45.1	45.9	46.8	47.7	48.6	49.5	50.3	51.2	52.1	53.0	.88
1.15	39.9	40.7	41.6	42.5	43.3	44.2	45.1	45.9	46.8	47.7	48.5	49.4	50.3	51.1	52.0	.87
1.18	39.1	40.0	40.8	41.7	42.5	43.4	44.2	45.1	45.9	46.8	47.6	48.4	49.3	50.2	51.0	.85
1.20	38.3	39.2	40.0	40.8	41.7	42.5	43.3	44.2	45.0	45.8	46.7	47.5	48.3	49.2	50.0	0.83
1.22	37.6	38.4	39.2	40.0	40.8	41.7	42.5	43.3	44.1	44.9	45.7	46.5	47.4	48.2	49.0	.82
1.25	36.8	37.6	38.4	39.2	40.0	40.8	41.6	42.4	43.2	44.0	44.8	45.6	46.4	47.2	48.0	.80
1.28	36.0	36.8	37.6	38.4	39.2	40.0	40.7	41.5	42.3	43.1	43.9	44.6	45.4	46.2	47.0	.78
1.30	35.3	36.0	36.8	37.6	38.3	39.1	39.9	40.6	41.4	42.2	42.9	43.7	44.5	45.2	46.0	.77
1.33	34.5	35.3	36.0	36.8	37.5	38.3	39.0	39.8	40.5	41.3	42.0	42.7	43.5	44.3	45.0	0.75
1.36	33.7	34.5	35.2	35.9	36.7	37.4	38.1	38.9	39.6	40.3	41.1	41.8	42.5	43.3	44.0	.73
1.40	33.0	33.7	34.4	35.1	35.8	36.6	37.3	38.0	38.7	39.4	40.1	40.8	41.6	42.3	43.0	.72
1.43	32.2	32.9	33.6	34.3	35.0	35.7	36.4	37.1	37.8	38.5	39.2	39.9	40.6	41.3	42.0	.70
1.46	31.4	32.1	32.8	33.5	34.2	34.9	35.5	36.2	36.9	37.6	38.3	38.9	39.6	40.3	41.0	.68
1.50	30.7	31.3	32.0	32.7	33.3	34.0	34.7	35.3	36.0	36.7	37.3	38.0	38.7	39.3	40.0	0.67
1.54	29.9	30.6	31.2	31.9	32.5	33.2	33.8	34.5	35.1	35.8	36.4	37.0	37.7	38.4	39.0	.65
1.58	29.1	29.8	30.4	31.0	31.7	32.3	32.9	33.6	34.2	34.8	35.5	36.1	36.7	37.4	38.0	.63
1.62	28.4	29.0	29.6	30.2	30.8	31.5	32.1	32.7	33.3	33.9	34.5	35.1	35.8	36.4	37.0	.62
1.67	27.6	28.2	28.8	29.4	30.0	30.6	31.2	31.8	32.4	33.0	33.6	34.2	34.8	35.4	36.0	.60
1.71	26.8	27.4	28.0	28.6	29.2	29.8	30.3	30.9	31.5	32.1	32.7	33.2	33.8	34.4	35.0	0.58
1.76	26.1	26.6	27.2	27.8	28.3	28.9	29.5	30.0	30.6	31.2	31.7	32.3	32.9	33.4	34.0	.57
1.82	25.3	25.9	26.4	27.0	27.5	28.1	28.6	29.2	29.7	30.3	30.8	31.3	31.9	32.5	33.0	.55
1.88	24.5	25.1	25.6	26.1	26.7	27.2	27.7	28.3	28.8	29.3	29.9	30.4	30.9	31.5	32.0	.53
1.94	23.8	24.3	24.8	25.3	25.8	26.4	26.9	27.4	27.9	28.4	28.9	29.4	30.0	30.5	31.0	.52
2.00	23.0	23.5	24.0	24.5	25.0	25.5	26.0	26.5	27.0	27.5	28.0	28.5	29.0	29.5	30.0	0.50
2.07	22.2	22.7	23.2	23.7	24.2	24.7	25.1	25.6	26.1	26.6	27.1	27.5	28.0	28.5	29.0	.48
2.14	21.5	21.9	22.4	22.9	23.3	23.8	24.3	24.7	25.2	25.7	26.1	26.6	27.1	27.5	28.0	.47
2.22	20.7	21.2	21.6	22.1	22.5	23.0	23.4	23.9	24.3	24.8	25.2	25.6	26.1	26.6	27.0	.45
2.31	19.9	20.4	20.8	21.2	21.7	22.1	22.5	23.0	23.4	23.8	24.3	24.7	25.1	25.6	26.0	.43
2.40	19.2	19.6	20.0	20.4	20.8	21.3	21.7	22.1	22.5	22.9	23.3	23.7	24.2	24.6	25.0	0.42
2.50	18.4	18.8	19.2	19.6	20.0	20.4	20.8	21.2	21.6	22.0	22.4	22.8	23.2	23.6	24.0	.40
2.61	17.6	18.0	18.4	18.8	19.2	19.6	19.9	20.3	20.7	21.1	21.5	21.8	22.2	22.6	23.0	.38
2.73	16.9	17.2	17.6	18.0	18.3	18.7	19.1	19.4	19.8	20.2	20.5	20.9	21.3	21.6	22.0	.37
2.86	16.1	16.5	16.8	17.2	17.5	17.9	18.2	18.6	18.9	19.3	19.6	19.9	20.3	20.7	21.0	.35
3.00	15.3	15.7	16.0	16.3	16.7	17.0	17.3	17.7	18.0	18.3	18.7	19.0	19.3	19.7	20.0	0.33
3.16	14.6	14.9	15.2	15.5	15.8	16.2	16.5	16.8	17.1	17.4	17.7	18.0	18.4	18.7	19.0	.32
3.33	13.8	14.1	14.4	14.7	15.0	15.3	15.6	15.9	16.2	16.5	16.8	17.1	17.4	17.7	18.0	.30
3.53	13.0	13.3	13.6	13.9	14.2	14.5	14.7	15.0	15.3	15.6	15.9	16.1	16.4	16.7	17.0	.28
3.75	12.3	12.5	12.8	13.1	13.3	13.6	13.9	14.1	14.4	14.7	14.9	15.2	15.5	15.7	16.0	.27
4.00	11.5	11.8	12.0	12.3	12.5	12.8	13.0	13.3	13.5	13.8	14.0	14.2	14.5	14.8	15.0	0.25
4.29	10.7	11.0	11.2	11.4	11.7	11.9	12.1	12.4	12.6	12.8	13.1	13.3	13.5	13.8	14.0	.23
4.62	10.0	10.2	10.4	10.6	10.8	11.1	11.3	11.5	11.7	11.9	12.1	12.3	12.6	12.8	13.0	.22
5.00	9.2	9.4	9.6	9.8	10.0	10.2	10.4	10.6	10.8	11.0	11.2	11.4	11.6	11.8	12.0	.20
5.45	8.4	8.6	8.8	9.0	9.2	9.4	9.5	9.7	9.9	10.1	10.3	10.4	10.6	10.8	11.0	.18
6.00	7.7	7.8	8.0	8.2	8.3	8.5	8.7	8.8	9.0	9.2	9.3	9.5	9.7	9.8	10.0	0.17
6.67	6.9	7.1	7.2	7.4	7.5	7.7	7.8	8.0	8.1	8.3	8.4	8.5	8.7	8.9	9.0	.15
7.50	6.1	6.3	6.4	6.5	6.7	6.8	6.9	7.1	7.2	7.3	7.5	7.6	7.7	7.9	8.0	.13
8.57	5.4	5.5	5.6	5.7	5.8	6.0	6.1	6.2	6.3	6.4	6.5	6.6	6.8	6.9	7.0	.12
10.0	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0	.10
12.0	3.8	3.9	4.0	4.1	4.2	4.3	4.3	4.4	4.5	4.6	4.7	4.7	4.8	4.9	5.0	0.08
15.0	3.1	3.1	3.2	3.3	3.3	3.4	3.5	3.5	3.6	3.7	3.7	3.8	3.9	3.9	4.0	.07
20.0	2.3	2.4	2.4	2.5	2.5	2.6	2.6	2.7	2.7	2.8	2.8	2.8	2.9	3.0	3.0	.05
30.0	1.5	1.6	1.6	1.6	1.7	1.7	1.7	1.8	1.8	1.8	1.9	1.9	1.9	2.0	2.0	.03
60.0	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	.02

b / B	a = 0° 0′				a = 0° 30′				a = 1° 0′				c / C	a / β
	h \ d	60′/Δ	Z \ t		h \ d	60′/Δ	Z \ t	Δ/60′	h \ d	60′/Δ	Z \ t	Δ/60′		
	° ′		° ′		° ′		° ′		° ′		° ′			
0	0 0	1	0 0		0 0	1	0 30	0.00	0 0	1	1 0	0.00	90	90.0
1	1 0	1	0		1 0	1	30	.00	1 0	1	0	.00	89	90.0
2	2 0	1	0		2 0	1	30	.00	2 0	1	0	.00	88	90.0
3	3 0	1	0		3 0	1	30	.00	3 0	1	0	.00	87	90.0
4	4 0	1	0		4 0	1	30	.00	4 0	1	0	.00	86	90.0
5	5 0	1	0		5 0	1	30	0.00	5 0	1	0	0.00	85	90.0
6	6 0	1	0		6 0	1	30	.00	6 0	1	0	.00	84	89.9
7	7 0	1	0		7 0	1	30	.00	7 0	1	0	.02	83	89.9
8	8 0	1	0		8 0	1	30	.00	8 0	1	1	.00	82	89.9
9	9 0	1	0		9 0	1	30	.02	9 0	1	1	.00	81	89.9
10	10 0	1	0		10 0	1	31	0.00	10 0	1	1	0.00	80	89.9
11	11 0	1	0		11 0	1	31	.00	11 0	1	1	.00	79	89.9
12	12 0	1	0		12 0	1	31	.00	12 0	1	1	.02	78	89.9
13	13 0	1	0		13 0	1	31	.00	13 0	1	2	.00	77	89.9
14	14 0	1	0		14 0	1	31	.00	14 0	1	2	.00	76	89.9
15	15 0	1	0		15 0	1	31	0.00	15 0	1	2	0.00	75	89.9
16	16 0	1	0		16 0	1	31	.00	16 0	1	2	.02	74	89.9
17	17 0	1	0		17 0	1	31	.02	17 0	1	3	.00	73	89.8
18	18 0	1	0		18 0	1	32	.00	18 0	1	3	.00	72	89.8
19	19 0	1	0		19 0	1	32	.00	19 0	1	3	.02	71	89.8
20	20 0	1	0		20 0	1	32	0.00	20 0	1	4	0.00	70	89.8
21	21 0	1	0		21 0	1	32	.00	21 0	1	4	.02	69	89.8
22	22 0	1	0		22 0	1	32	.02	22 0	1	5	.00	68	89.8
23	23 0	1	0		23 0	1	33	.00	23 0	1	5	.02	67	89.8
24	24 0	1	0		24 0	1	33	.00	24 0	1	6	.00	66	89.8
25	25 0	1	0		25 0	1	33	0.00	25 0	1	6	0.02	65	89.8
26	26 0	1	0		26 0	1	33	.02	26 0	1	7	.00	64	89.8
27	27 0	1	0		27 0	1	34	.00	27 0	1	7	.02	63	89.7
28	28 0	1	0		28 0	1	34	.00	28 0	1	8	.02	62	89.7
29	29 0	1	0		29 0	1	34	.02	29 0	1	9	.00	61	89.7
30	30 0	1	0		30 0	1	35	0.00	30 0	1	9	0.02	60	89.7
31	31 0	1	0		31 0	1	35	.00	31 0	1	10	.02	59	89.7
32	32 0	1	0		32 0	1	35	.02	32 0	1	11	.02	58	89.7
33	33 0	1	0		33 0	1	36	.00	33 0	1	12	.00	57	89.7
34	34 0	1	0		34 0	1	36	.02	34 0	1	12	.02	56	89.7
35	35 0	1	0		35 0	1	37	0.00	35 0	1	13	0.02	55	89.7
36	36 0	1	0		36 0	1	37	.02	36 0	1	14	.02	54	89.6
37	37 0	1	0		37 0	1	38	.00	37 0	1	15	.02	53	89.6
38	38 0	1	0		38 0	1	38	.02	38 0	1	16	.02	52	89.6
39	39 0	1	0		39 0	1	39	.00	39 0	1	17	.02	51	89.6
40	40 0	1	0		40 0	1	39	0.02	40 0	1	18	0.02	50	89.6
41	41 0	1	0		41 0	1	40	.00	41 0	1	19	.03	49	89.6
42	42 0	1	0		42 0	1	40	.02	42 0	1	21	.02	48	89.6
43	43 0	1	0		43 0	1	41	.02	43 0	1.02	22	.02	47	89.5
44	44 0	1	0		44 0	1	42	.00	59	1	23	.03	46	89.5
45	45 0		0		45 0		42		44 59		25		45	89.5
t	a	60′/Δ	b		a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′		a
	d = 0° 0′				d = 0° 30′				d = 1° 0′					

b / B	a = 0° 0′					a = 0° 30′						a = 1° 0′						c / C	a / β
	h	d	60′/Δ	Z	t	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′		
°	° ′			° ′		° ′			° ′			° ′			° ′			°	°
45	45 0		1	0 0		45 0		1	0 42		0.02	44 59		1	1 25		0.02	45	89.5
46	46 0		1		0	46 0		1		43	.02	45 59		1		26	.03	44	89.5
47	47 0		1		0	47 0		1		44	.02	46 59		1		28	.03	43	89.5
48	48 0		1		0	48 0		1		45	.02	47 59		1		30	.02	42	89.4
49	49 0		1		0	49 0		1		46	.02	48 59		1		31	.03	41	89.4
50	50 0		1		0	50 0		1		47	0.02	49 59		1		33	0.03	40	89.4
51	51 0		1		0	51 0		1		48	.02	50 59		1		35	.03	39	89.4
52	52 0		1		0	52 0		1		49	.02	51 59		1		37	.05	38	89.4
53	53 0		1		0	53 0		1		50	.02	52 59		1		40	.03	37	89.3
54	54 0		1		0	54 0		1		51	.02	53 59		1		42	.05	36	89.3
55	55 0		1		0	55 0		1		52	0.03	54 59		1		45	0.03	35	89.3
56	56 0		1		0	56 0		1		54	.02	55 59		1		47	.05	34	89.3
57	57 0		1		0	57 0		1		55	.03	56 59		1		50	.05	33	89.2
58	58 0		1		0	58 0		1		57	.02	57 59		1		53	.05	32	89.2
59	59 0		1		0	59 0		1		58	.03	58 59		1		56	.07	31	89.2
60	60 0		1		0	60 0		1	1 0		0.03	59 59		1	2 0		0.07	30	89.1
61	61 0		1		0	61 0		1		2	.03	60 59		1		4	.07	29	89.1
62	62 0		1		0	62 0		1		4	.03	61 59		1		8	.07	28	89.1
63	63 0		1		0	63 0		1		6	.03	62 59		1		12	.08	27	89.0
64	64 0		1		0	64 0		1		8	.05	63 59		1		17	.08	26	89.0
65	65 0		1		0	65 0		1		11	0.05	64 59		1		22	0.08	25	88.9
66	66 0		1		0	66 0		1		14	.05	65 59		1		27	.10	24	88.9
67	67 0		1		0	67 0		1		17	.05	66 59		1		33	.12	23	88.8
68	68 0		1		0	68 0		1		20	.07	67 59		1		40	.12	22	88.8
69	69 0		1		0	69 0		1		24	.07	68 59		1		47	.13	21	88.7
70	70 0		1		0	70 0		1		28	0.07	69 59		1.02		55	0.15	20	88.6
71	71 0		1		0	71 0		1		32	.08	70 58		1	3 4		.17	19	88.5
72	72 0		1		0	72 0		1		37	.10	71 58		1		14	.18	18	88.5
73	73 0		1		0	73 0		1		43	.10	72 58		1		25	.20	17	88.4
74	74 0		1		0	74 0		1		49	.12	73 58		1		37	.23	16	88.3
75	75 0		1		0	75 0		1.02		56	0.13	74 58		1		51	0.28	15	88.1
76	76 0		1		0		59	1	2 4		.15	75 58		1	4 8		.30	14	88.0
77	77 0		1		0	76	59	1		13	.18	76 58		1		26	.37	13	87.8
78	78 0		1		0	77	59	1		24	.22	77 58		1.02		48	.43	12	87.6
79	79 0		1		0	78	59	1		37		78 57		1	5 14			11	87.4
80	80 0		1		0	79	59	1		53		79 57		1		44		10	87.2
81	81 0		1		0	80	59	1	3 12			80 57		1.02	6 22			9	86.8
82	82 0		1		0	81	59	1		35		81 56		1	7 9			8	86.4
83	83 0		1		0	82	59	1	4 6			82 56		1.02	8 9			7	85.9
84	84 0		1		0	83	59	1		46		83 55		1.02	9 29			6	85.3
85	85 0		1		0	84	59	1.02	5 43			84 54		1.02	11 20			5	84.3
86	86 0		1		0	85	58	1	7 8			85 53		1.05	14 3			4	82.9
87	87 0		1		0	86	58	1.03	9 28			86 50		1.07	18 27			3	80.5
88	88 0		1		0	87	56	1.05	14 2			87 46		1.22	26 34			2	76.0
89	89 0		1		0	88	53	1.62	26 34			88 35		2.40	45 0			1	63.4
90	90 0				0	89	30		90 0			89 0			90 0			0	0.0
t	a		60′/Δ		b	a		60′/Δ		b	Δ/60′	a		60′/Δ		b	Δ/60′		α
	d = 0° 0′					d = 0° 30′						d = 1° 0′							

b / B	a = 1° 30′						a = 2° 0′						a = 2° 30′						c / C	a / β
	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′		
°	°	′		°	′		°	′		°	′		°	′		°	′			°
0	0	0	1	1	30	0.00	0	0	1	2	0	0.00	0	0	1	2	30	0.00	90	90.0
1	1	0	1		30	.00	1	0	1		0	.00	1	0	1		30	.00	89	90.0
2	2	0	1		30	.00	2	0	1		0	.00	2	0	1		30	.00	88	89.9
3	3	0	1		30	.00	3	0	1		0	.00	3	0	1		30	.00	87	89.9
4	4	0	1		30	.00	4	0	1		0	.00	4	0	1		30	.02	86	89.9
5	5	0	1		30	0.00	5	0	1		0	0.02	5	0	1		31	0.00	85	89.8
6	6	0	1		30	.02	6	0	1		1	.00	6	0	1		31	.00	84	89.8
7	7	0	1		31	.00	7	0	1		1	.00	7	0	1		31	.00	83	89.8
8	8	0	1		31	.00	8	0	1		1	.00	8	0	1.02		31	.02	82	89.7
9	9	0	1		31	.00	9	0	1		1	.02		59	1		32	.00	81	89.7
10	10	0	1		31	0.02	10	0	1		2	0.00	9	59	1		32	0.02	80	89.6
11	11	0	1		32	.00	11	0	1		2	.02	10	59	1		33	.00	79	89.6
12	12	0	1		32	.00	12	0	1		3	.00	11	59	1		33	.02	78	89.6
13	13	0	1		32	.02	13	0	1.02		3	.02	12	59	1		34	.02	77	89.5
14	14	0	1		33	.00		59	1		4	.00	13	59	1		35	.00	76	89.5
15	15	0	1		33	0.02	14	59	1		4	0.02	14	59	1		35	0.02	75	89.5
16	16	0	1		34	.00	15	59	1		5	.00	15	59	1		36	.02	74	89.4
17	17	0	1		34	.02	16	59	1		5	.02	16	59	1		37	.02	73	89.4
18	18	0	1		35	.00	17	59	1		6	.02	17	59	1		38	.02	72	89.4
19	19	0	1		35	.02	18	59	1		7	.02	18	59	1		39	.02	71	89.3
20	20	0	1		36	0.00	19	59	1		8	0.02	19	59	1		40	0.02	70	89.3
21	21	0	1		36	.02	20	59	1		9	.00	20	59	1		41	.02	69	89.2
22	22	0	1.02		37	.02	21	59	1		9	.02	21	59	1		42	.02	68	89.2
23		59	1		38	.02	22	59	1		10	.02	22	59	1		43	.02	67	89.2
24	23	59	1		39	.00	23	59	1		11	.02	23	59	1.02		44	.02	66	89.1
25	24	59	1		39	0.02	24	59	1		12	0.02	24	58	1		45	0.03	65	89.1
26	25	59	1		40	.02	25	59	1		13	.03	25	58	1		47	.02	64	89.0
27	26	59	1		41	.02	26	59	1		15	.02	26	58	1		48	.03	63	89.0
28	27	59	1		42	.02	27	59	1		16	.02	27	58	1		50	.02	62	88.9
29	28	59	1		43	.02	28	59	1		17	.03	28	58	1		51	.03	61	88.9
30	29	59	1		44	0.02	29	59	1		19	0.02	29	58	1		53	0.03	60	88.8
31	30	59	1		45	.02	30	59	1		20	.02	30	58	1		55	.03	59	88.8
32	31	59	1		46	.02	31	59	1		21	.03	31	58	1		57	.03	58	88.8
33	32	59	1		47	.03	32	59	1		23	.03	32	58	1		59	.03	57	88.7
34	33	59	1		49	.02	33	59	1		25	.02	33	58	1	3	1	.03	56	88.7
35	34	59	1		50	0.02	34	59	1.02		26	0.03	34	58	1		3	0.03	55	88.6
36	35	59	1		51	.03	35	58	1		28	.03	35	58	1		5	.05	54	88.5
37	36	59	1		53	.02	36	58	1		30	.03	36	58	1.02		8	.03	53	88.5
38	37	59	1		54	.03	37	58	1		32	.03	37	57	1		10	.05	52	88.4
39	38	59	1		56	.02	38	58	1		34	.05	38	57	1		13	.05	51	88.4
40	39	59	1		57	0.03	39	58	1		37	0.03	39	57	1		16	0.05	50	88.3
41	40	59	1		59	.03	40	58	1		39	.03	40	57	1		19	.05	49	88.3
42	41	59	1	2	1	.03	41	58	1		41	.05	41	57	1		22	.05	48	88.2
43	42	59	1		3	.03	42	58	1		44	.05	42	57	1		25	.05	47	88.1
44	43	59	1		5	.03	43	58	1		47	.05	43	57	1		28	.07	46	88.1
45	44	59			7		44	58			50		44	57			32		45	88.0
t	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′		a
	d = 1° 30′						d = 2° 0′						d = 2° 30′							

b / B	a = 1° 30′					a = 2° 0′					a = 2° 30′					c / C	a / β
	h \ d	60′/Δ	Z \ t	Δ/60′		h \ d	60′/Δ	Z \ t	Δ/60′		h \ d	60′/Δ	Z \ t	Δ/60′			
°	° ′		° ′			° ′		° ′			° ′		° ′			°	°
45	44 59	1	2 7	0.03		44 58	1	2 50	0.05		44 57	1	3 32	0.07		45	88.0
46	45 59	1	9	.05		45 58	1	53	.05		45 57	1.02	36	.07		44	87.9
47	46 59	1	12	.03		46 58	1	56	.05		46 56	1	40	.07		43	87.9
48	47 59	1	14	.05		47 58	1	59	.07		47 56	1	44	.07		42	87.8
49	48 59	1	17	.05		48 58	1	3 3	.07		48 56	1	48	.08		41	87.7
50	49 59	1	20	0.05		49 58	1.02	7	0.07		49 56	1	53	0.08		40	87.6
51	50 59	1.02	23	.05		50 57	1	11	.07		50 56	1	58	.08		39	87.5
52	51 58	1	26	.05		51 57	1	15	.07		51 56	1	4 3	.10		38	87.4
53	52 58	1	29	.07		52 57	1	19	.08		52 56	1	9	.10		37	87.3
54	53 58	1	33	.07		53 57	1	24	.08		53 56	1.02	15	.10		36	87.2
55	54 58	1	37	0.07		54 57	1	29	0.08		54 55	1	21	0.12		35	87.1
56	55 58	1	41	.07		55 57	1	34	.10		55 55	1	28	.12		34	87.0
57	56 58	1	45	.08		56 57	1	40	.10		56 55	1	35	.13		33	86.9
58	57 58	1	50	.08		57 57	1	46	.12		57 55	1	43	.13		32	86.8
59	58 58	1	55	.08		58 57	1.02	53	.12		58 55	1.02	51	.15		31	86.7
60	59 58	1	3 0	0.10		59 56	1	4 0	0.12		59 54	1	5 0	0.15		30	86.5
61	60 58	1	6	.10		60 56	1	7	.13		60 54	1	9	.17		29	86.4
62	61 58	1	12	.10		61 56	1	15	.15		61 54	1	19	.18		28	86.2
63	62 58	1	18	.12		62 56	1	24	.15		62 54	1.02	30	.18		27	86.1
64	63 58	1.02	25	.13		63 56	1	33	.17		63 53	1	41	.22		26	85.9
65	64 57	1	33	0.13		64 56	1.02	43	0.18		64 53	1	54	0.23		25	85.7
66	65 57	1	41	.15		65 55	1	54	.20		65 53	1.02	6 8	.25		24	85.5
67	66 57	1	50	.17		66 55	1	5 6	.22		66 52	1	23	.27		23	85.3
68	67 57	1	4 0	.18		67 55	1	19	.25		67 52	1	39	.30		22	85.1
69	68 57	1	11	.20		68 55	1.02	34	.27		68 52	1.02	57	.32		21	84.8
70	69 57	1	23	0.22		69 54	1	50	0.28		69 51	1	7 16	0.37		20	84.5
71	70 57	1.02	36	.25		70 54	1	6 7	.33		70 51	1.02	38	.42		19	84.2
72	71 56	1	51	.27		71 54	1.02	27	.37		71 50	1.02	8 3	.45		18	83.9
73	72 56	1	5 7	.32		72 53	1	49	.40		72 49	1	30	.50		17	83.5
74	73 56	1	26	.35		73 53	1.02	7 13	.47		73 49	1.02	9 0	.58		16	83.1
75	74 56	1.02	47	0.40		74 52	1	41	0.53		74 48	1.02	35	0.65		15	82.6
76	75 55	1	6 11	.47		75 52	1.02	8 13	.62		75 47	1.02	10 14	.75		14	82.0
77	76 55	1.02	39	.53		76 51	1.02	50	.70		76 46	1.02	59	.88		13	81.4
78	77 54	1	7 11	.63		77 50	1.02	9 32	.83		77 45	1.03	11 52	1.02		12	80.7
79	78 54	1.02	49			78 49	1.02	10 22			78 43	1.02	12 53	1.23		11	79.8
80	79 53	1	8 35			79 48	1.02	11 22			79 42	1.03	14 7			10	78.8
81	80 53	1.02	9 30			80 47	1.03	12 35			80 40	1.05	15 36			9	77.6
82	81 52	1.02	10 39			81 45	1.03	14 5			81 37	1.05	17 25			8	76.1
83	82 51	1.03	12 8			82 43	1.03	15 59			82 34	1.07	19 43			7	74.1
84	83 49	1.03	14 4			83 41	1.07	18 28			83 30	1.09	22 40			6	71.6
85	84 47	1.05	16 43			84 37	1.09	21 50			84 25	1.15	26 37			5	68.3
86	85 44	1.09	20 35			85 32	1.15	26 36			85 17	1.22	32 3			4	63.5
87	86 39	1.18	26 35			86 24	1.30	33 43			86 6	1.43	39 50			3	56.3
88	87 30	1.43	36 53			87 10	1.67	45 1			48	2.00	51 22			2	45.0
89	88 12	3.33	56 19			46	4.29	63 27			87 18	5.00	68 13			1	26.6
90	30		90 0			88 0		90 0			30		90 0			0	0.0
t	a	60′/Δ	b	Δ/60′		a	60′/Δ	b	Δ/60′		a	60′/Δ	b	Δ/60′			a
	d = 1° 30′					d = 2° 0′					d = 2° 30′						

b / B	a = 3° 0′						a = 3° 30′						a = 4° 0′						c / C	α / β
	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′		
	°	′		°	′		°	′		°	′		°	′		°	′			
0	0	0	1	3	0	0.00	0	0	1	3	30	0.00	0	0	1	4	0	0.00	90	90.0
1	1	0	1		0	.00	1	0	1		30	.00	1	0	1		0	.00	89	89.9
2	2	0	1		0	.00	2	0	1		30	.00	2	0	1		0	.00	88	89.9
3	3	0	1		0	.00	3	0	1		30	.02	3	0	1.02		0	.02	87	89.8
4	4	0	1		0	.02	4	0	1.02		31	.00		59	1		1	.00	86	89.8
5	5	0	1		1	0.00		59	1		31	0.00	4	59	1		1	0.00	85	89.7
6	6	0	1.02		1	.00	5	59	1		31	.02	5	59	1		1	.02	84	89.6
7		59	1		1	.02	6	59	1		32	.00	6	59	1		2	.00	83	89.6
8	7	59	1		2	.00	7	59	1		32	.02	7	59	1		2	.02	82	89.5
9	8	59	1		2	.02	8	59	1		33	.00	8	59	1		3	.02	81	89.4
10	9	59	1		3	0.00	9	59	1		33	0.02	9	59	1.02		4	0.00	80	89.4
11	10	59	1		3	.02	10	59	1		34	.02	10	58	1		4	.02	79	89.3
12	11	59	1		4	.02	11	59	1		35	.02	11	58	1		5	.02	78	89.3
13	12	59	1		5	.00	12	59	1.02		36	.00	12	58	1		6	.02	77	89.2
14	13	59	1		5	.02	13	58	1		36	.02	13	58	1		7	.02	76	89.1
15	14	59	1		6	0.02	14	58	1		37	0.02	14	58	1		8	0.03	75	89.1
16	15	59	1		7	.02	15	58	1		38	.02	15	58	1.02		10	.02	74	89.0
17	16	59	1.02		8	.02	16	58	1		39	.03	16	57	1		11	.02	73	88.9
18	17	58	1		9	.02	17	58	1		41	.02	17	57	1		12	.03	72	88.9
19	18	58	1		10	.02	18	58	1		42	.02	18	57	1		14	.02	71	88.8
20	19	58	1		11	0.03	19	58	1		43	0.03	19	57	1		15	0.03	70	88.7
21	20	58	1		13	.02	20	58	1.02		45	.02	20	57	1		17	.03	69	88.7
22	21	58	1		14	.02	21	57	1		46	.03	21	57	1.02		19	.03	68	88.6
23	22	58	1		15	.03	22	57	1		48	.03	22	56	1		21	.03	67	88.5
24	23	58	1		17	.02	23	57	1		50	.03	23	56	1		23	.03	66	88.4
25	24	58	1		18	0.03	24	57	1		52	0.03	24	56	1		25	0.03	65	88.4
26	25	58	1		20	.03	25	57	1		54	.03	25	56	1		27	.03	64	88.3
27	26	58	1.02		22	.03	26	57	1		56	.03	26	56	1		29	.05	63	88.2
28	27	57	1		24	.03	27	57	1.02		58	.03	27	56	1.02		32	.03	62	88.1
29	28	57	1		26	.03	28	56	1	4	0	.03	28	55	1		34	.05	61	88.1
30	29	57	1		28	0.03	29	56	1		2	0.05	29	55	1		37	0.05	60	88.0
31	30	57	1		30	.03	30	56	1		5	.05	30	55	1		40	.05	59	87.9
32	31	57	1		32	.03	31	56	1		8	.03	31	55	1		43	.05	58	87.8
33	32	57	1		34	.05	32	56	1		10	.05	32	55	1.02		46	.05	57	87.7
34	33	57	1		37	.05	33	56	1		13	.05	33	54	1		49	.07	56	87.6
35	34	57	1		40	0.03	34	56	1.02		16	0.05	34	54	1		53	0.05	55	87.6
36	35	57	1.02		42	.05	35	55	1		19	.07	35	54	1		56	.07	54	87.5
37	36	56	1		45	.05	36	55	1		23	.05	36	54	1.02	5	0	.07	53	87.4
38	37	56	1		48	.05	37	55	1		26	.07	37	53	1		4	.07	52	87.3
39	38	56	1		51	.07	38	55	1		30	.07	38	53	1		8	.08	51	87.2
40	39	56	1		55	0.05	39	55	1.02		34	0.07	39	53	1		13	0.08	50	87.1
41	40	56	1		58	.07	40	54	1		38	.07	40	53	1.02		18	.08	49	87.0
42	41	56	1	4	2	.07	41	54	1		42	.08	41	52	1		23	.08	48	86.9
43	42	56	1.02		6	.07	42	54	1		47	.08	42	52	1		28	.08	47	86.7
44	43	55	1		10	.07	43	54	1		52	.08	43	52	1		33	.10	46	86.6
45	44	55			14		44	54			57		44	52			39		45	86.5
t	a	60′/Δ	b	Δ/60′			a	60′/Δ	b	Δ/60′			a	60′/Δ	b	Δ/60′				α
	d = 3° 0′						d = 3° 30′						d = 4° 0′							

b / B	a = 3° 0′ h	d	60′/Δ	t Z	Δ/60′	a = 3° 30′ h	d	60′/Δ	t Z	Δ/60′	a = 4° 0′ h	d	60′/Δ	t Z	Δ/60′	c / C	a / β
°	° ′			° ′		° ′			° ′		° ′			° ′		°	°
45	44 55		1	4 14	0.08	44 54		1.02	4 57	0.08	44 52		1.02	5 39	0.10	45	86.5
46	45 55		1	19	.08	45 53		1	5 2	.08	45 51		1	45	.10	44	86.4
47	46 55		1	24	.08	46 53		1	7	.10	46 51		1	51	.12	43	86.3
48	47 55		1	29	.08	47 53		1	13	.10	47 51		1.02	58	.12	42	86.1
49	48 55		1.02	34	.10	48 53		1.02	19	.12	48 50		1	6 5	.13	41	86.0
50	49 54		1	40	0.10	49 52		1	26	0.12	49 50		1	13	0.13	40	85.8
51	50 54		1	46	.10	50 52		1	33	.12	50 50		1.02	21	.13	39	85.7
52	51 54		1	52	.12	51 52		1.02	40	.13	51 49		1	29	.15	38	85.5
53	52 54		1	59	.12	52 51		1	48	.13	52 49		1	38	.15	37	85.4
54	53 54		1.02	5 6	.12	53 51		1	56	.15	53 49		1.02	47	.17	36	85.2
55	54 53		1	13	0.13	54 51		1.02	6 5	0.15	54 48		1	57	0.18	35	85.0
56	55 53		1	21	.15	55 50		1	14	.17	55 48		1.02	7 8	.18	34	84.8
57	56 53		1.02	30	.15	56 50		1	24	.18	56 47		1	19	.20	33	84.6
58	57 52		1	39	.17	57 50		1.02	35	.18	57 47		1.02	31	.22	32	84.4
59	58 52		1	49	.17	58 49		1	46	.20	58 46		1	44	.23	31	84.2
60	59 52		1	59	0.18	59 49		1.02	58	0.22	59 46		1.02	58	0.25	30	84.0
61	60 52		1.02	6 10	.20	60 48		1	7 11	.23	60 45		1.02	8 13	.25	29	83.7
62	61 51		1	22	.22	61 48		1.02	25	.25	61 44		1	28	.28	28	83.5
63	62 51		1.02	35	.23	62 47		1	40	.27	62 44		1.02	45	.32	27	83.2
64	63 50		1	49	.25	63 47		1.02	56	.30	63 43		1.02	9 4	.33	26	82.9
65	64 50		1.02	7 4	0.27	64 46		1	8 14	0.32	64 42		1.02	24	0.35	25	82.5
66	65 49		1	20	.30	65 46		1.02	33	.35	65 41		1.02	45	.40	24	82.2
67	66 49		1.02	38	.33	66 45		1.02	54	.37	66 40		1.02	10 9	.42	23	81.8
68	67 48		1	58	.35	67 44		1.02	9 16	.42	67 39		1.02	34	.47	22	81.4
69	68 48		1.02	8 19	.40	68 43		1.02	41	.45	68 38		1.02	11 2	.52	21	81.0
70	69 47		1.02	43	0.43	69 42		1.02	10 8	0.50	69 37		1.02	33	0.57	20	80.5
71	70 46		1	9 9	.48	70 41		1.02	38	.57	70 36		1.02	12 7	.63	19	79.9
72	71 46		1.02	38	.53	71 40		1.02	11 12	.62	71 35		1.03	45	.70	18	79.4
73	72 45		1.02	10 10	.60	72 39		1.02	49	.70	72 33		1.03	13 27	.78	17	78.7
74	73 44		1.02	46	.68	73 38		1.03	12 31	.78	73 31		1.03	14 14	.88	16	78.0
75	74 43		1.03	11 27	0.77	74 36		1.02	13 18	0.88	74 29		1.03	15 7	1.00	15	77.2
76	75 41		1.02	12 13	.90	75 35		1.03	14 11	1.03	75 27		1.03	16 7	1.15	14	76.2
77	76 40		1.03	13 7	1.03	76 33		1.05	15 13	1.18	76 25		1.05	17 16	1.32	13	75.2
78	77 38		1.03	14 9	1.22	77 30		1.03	16 24	1.37	77 22		1.07	18 35	1.55	12	74.0
79	78 36		1.03	15 22	1.43	78 28		1.05	17 46	1.63	78 18		1.07	20 8	1.80	11	72.6
80	79 34		1.05	16 48		79 25		1.07	19 24		79 14		1.09	21 56		10	70.9
81	80 31		1.05	18 31		80 21		1.09	21 21		80 9		1.09	24 5		9	68.9
82	81 28		1.09	20 38		81 16		1.09	23 43		81 4		1.13	26 41		8	66.5
83	82 23		1.09	23 16		82 11		1.15	26 39			57	1.18	29 51		7	63.6
84	83 18		1.15	26 38		83 3		1.18	30 20		82 48		1.25	33 47		6	59.9
85	84 10		1.20	31 1			54	1.28	35 4		83 36		1.33	38 44		5	55.1
86	85 0		1.33	36 55		84 41		1.43	41 15		84 21		1.54	45 4		4	48.9
87		45	1.54	45 2		85 23		1.71	49 27		85 0		1.88	53 11		3	40.6
88	86 24		2.31	56 20			58	2.50	60 17			32	2.86	63 29		2	29.8
89		50	6.00	71 35		86 22		7.50	74 4			53	8.57	75 59		1	10.0
90	87 0			90 0			30		90 0		86 0			90 0		0	0.0
t	a	60′/Δ		b	Δ/60′	a	60′/Δ		b	Δ/60′	a	60′/Δ		b	Δ/60′		a
	d = 3° 0′					d = 3° 30′					d = 4° 0′						

b / B	a = 4° 30′					a = 5° 0′					a = 5° 30′					c / C	a / β
	h	d	60′/Δ	Z	Δ/60′	h	d	60′/Δ	Z	Δ/60′	h	d	60′/Δ	Z	Δ/60′		
°	° ′			° ′		° ′			° ′		° ′			° ′		°	°
0	0 0		1	4 30	0.00	0 0		1	5 0	0.00	0 0		1	5 30	0.00	90	90.0
1	1 0		1	30	.00	1 0		1	0	.00	1 0		1.02	30	.00	89	89.9
2	2 0		1.02	30	.00	2 0		1.02	0	.00		59	1	30	.00	88	89.8
3		59	1	30	.02		59	1	0	.02	2	59	1	30	.02	87	89.7
4	3	59	1	31	.00	3	59	1	1	.00	3	59	1	31	.00	86	89.7
5	4	59	1	31	0.00	4	59	1	1	0.02	4	59	1.02	31	0.02	85	89.6
6	5	59	1	31	.02	5	59	1.02	2	.00	5	58	1	32	.00	84	89.5
7	6	59	1	32	.02	6	58	1	2	.02	6	58	1	32	.02	83	89.4
8	7	59	1.02	33	.00	7	58	1	3	.02	7	58	1	33	.02	82	89.3
9	8	58	1	33	.02	8	58	1	4	.02	8	58	1.02	34	.02	81	89.2
10	9	58	1	34	0.02	9	58	1.02	5	0.02	9	57	1	35	0.02	80	89.1
11	10	58	1	35	.02	10	57	1	6	.02	10	57	1	36	.02	79	89.0
12	11	58	1	36	.02	11	57	1	7	.02	11	57	1.02	37	.03	78	88.9
13	12	58	1.02	37	.02	12	57	1	8	.02	12	56	1	39	.02	77	88.8
14	13	57	1	38	.02	13	57	1.02	9	.02	13	56	1	40	.03	76	88.8
15	14	57	1	39	0.03	14	56	1	10	0.03	14	56	1.02	42	0.02	75	88.7
16	15	57	1	41	.02	15	56	1	12	.03	15	55	1	43	.03	74	88.6
17	16	57	1	42	.03	16	56	1	14	.02	16	55	1	45	.03	73	88.5
18	17	57	1.02	44	.02	17	56	1.02	15	.03	17	55	1	47	.03	72	88.4
19	18	56	1	45	.03	18	55	1	17	.03	18	55	1.02	49	.03	71	88.3
20	19	56	1	47	0.03	19	55	1	19	0.03	19	54	1	51	0.03	70	88.2
21	20	56	1	49	.03	20	55	1	21	.03	20	54	1	53	.05	69	88.1
22	21	56	1	51	.03	21	55	1.02	23	.05	21	54	1.02	56	.03	68	88.0
23	22	56	1.02	53	.03	22	54	1	26	.03	22	53	1	58	.05	67	87.9
24	23	55	1	55	.05	23	54	1	28	.05	23	53	1	6 1	.05	66	87.8
25	24	55	1	58	0.03	24	54	1	31	0.05	24	53	1.02	4	0.05	65	87.7
26	25	55	1	5 0	.05	25	54	1.02	34	.05	25	52	1	7	.05	64	87.6
27	26	55	1.02	3	.05	26	53	1	37	.05	26	52	1	10	.05	63	87.5
28	27	54	1	6	.05	27	53	1	40	.05	27	52	1.02	13	.07	62	87.3
29	28	54	1	9	.05	28	53	1.02	43	.05	28	51	1	17	.07	61	87.2
30	29	54	1	12	0.05	29	52	1	46	0.07	29	51	1.02	21	0.07	60	87.1
31	30	54	1.02	15	.05	30	52	1	50	.05	30	50	1	25	.07	59	87.0
32	31	53	1	18	.07	31	52	1	53	.07	31	50	1	29	.07	58	86.9
33	32	53	1	22	.05	32	52	1.02	57	.07	32	50	1.02	33	.07	57	86.8
34	33	53	1	25	.07	33	51	1	6 1	.08	33	49	1	37	.08	56	86.6
35	34	53	1.02	29	0.07	34	51	1	6	0.07	34	49	1	42	0.08	55	86.5
36	35	52	1	33	.08	35	51	1.02	10	.08	35	49	1.02	47	.08	54	86.4
37	36	52	1	38	.07	36	50	1	15	.08	36	48	1	52	.10	53	86.2
38	37	52	1.02	42	.08	37	50	1.02	20	.08	37	48	1.02	58	.10	52	86.1
39	38	51	1	47	.08	38	49	1	25	.10	38	47	1	7 4	.10	51	86.0
40	39	51	1	52	0.08	39	49	1	31	0.10	39	47	1.02	10	0.10	50	85.8
41	40	51	1.02	57	.10	40	49	1.02	37	.10	40	46	1	16	.12	49	85.7
42	41	50	1	6 3	.10	41	48	1	43	.10	41	46	1.02	23	.12	48	85.5
43	42	50	1	9	.10	42	48	1.02	49	.12	42	45	1	30	.12	47	85.4
44	43	50	1.02	15	.10	43	47	1	56	.12	43	45	1.02	37	.13	46	85.2
45	44	49		21		44	47		7 3		44	44		45		45	85.0
t	a	60′/Δ	b	Δ/60′		a	60′/Δ	b	Δ/60′		a	60′/Δ	b	Δ/60′			a
	d = 4° 30′					d = 5° 0′					d = 5° 30′						

b / B	$a = 4° 30'$						$a = 5° 0'$						$a = 5° 30'$						c / C	a / β
	h \ d	d	60′/Δ	Z \ t	t	Δ/60′	h \ d	d	60′/Δ	Z \ t	t	Δ/60′	h \ d	d	60′/Δ	Z \ t	t	Δ/60′		
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
45	44 49		1	6 21		0.12	44 47		1.02	7 3		0.13	44 44		1	7 45		0.13	45	85.0
46	45 49		1	28		.12	45 46		1	11		.13	45 44		1.02	53		.15	44	84.8
47	46 49		1.02	35		.12	46 46		1.02	19		.13	46 43		1.02	8 2		.15	43	84.7
48	47 48		1	42		.13	47 45		1	27		.15	47 42		1	11		.17	42	84.5
49	48 48		1.02	50		.15	48 45		1.02	36		.15	48 42		1.02	21		.17	41	84.3
50	49 47		1	59		0.15	49 44		1	45		0.17	49 41		1	31		0.18	40	84.1
51	50 47		1.02	7 8		.15	50 44		1.02	55		.17	50 41		1.02	42		.18	39	83.9
52	51 46		1	17		.17	51 43		1	8 5		.18	51 40		1.02	53		.20	38	83.6
53	52 46		1.02	27		.18	52 43		1.02	16		.20	52 39		1.02	9 5		.22	37	83.4
54	53 45		1	38		.18	53 42		1.02	28		.20	53 38		1	18		.23	36	83.2
55	54 45		1.02	49		0.20	54 41		1	40		0.22	54 38		1.02	32		0.23	35	82.9
56	55 44		1	8 1		.20	55 41		1.02	53		.23	55 37		1.02	46		.27	34	82.6
57	56 44		1.02	13		.23	56 40		1.02	9 7		.25	56 36		1.02	10 2		.27	33	82.4
58	57 43		1.02	27		.25	57 39		1.02	22		.27	57 35		1.02	18		.28	32	82.1
59	58 42		1	42		.25	58 38		1.02	38		.30	58 34		1.02	35		.32	31	81.7
60	59 42		1.02	57		0.27	59 37		1.02	56		0.30	59 33		1.02	54		0.33	30	81.4
61	60 41		1.02	9 13		.30	60 36		1.02	10 14		.32	60 32		1.03	11 14		.35	29	81.1
62	61 40		1.02	31		.32	61 35		1.02	33		.35	61 30		1.02	35		.38	28	80.7
63	62 39		1.02	50		.35	62 34		1.02	54		.38	62 29		1.02	58		.42	27	80.3
64	63 38		1.02	10 11		.37	63 33		1.02	11 17		.42	63 28		1.03	12 23		.45	26	79.9
65	64 37		1.02	33		0.40	64 32		1.02	42		0.43	64 26		1.02	50		0.48	25	79.4
66	65 36		1.02	57		.43	65 31		1.03	12 8		.48	65 25		1.03	13 19		.53	24	78.9
67	66 35		1.02	11 23		.48	66 29		1.02	37		.53	66 23		1.03	51		.57	23	78.4
68	67 34		1.02	52		.52	67 28		1.03	13 9		.57	67 21		1.03	14 25		.62	22	77.8
69	68 33		1.03	12 23		.57	68 26		1.02	43		.63	68 19		1.03	15 2		.68	21	77.2
70	69 31		1.02	57		0.63	69 25		1.03	14 21		0.68	69 17		1.03	43		0.75	20	76.5
71	70 30		1.03	13 35		.70	70 23		1.05	15 2		.77	70 15		1.05	16 28		.83	19	75.8
72	71 28		1.03	14 17		.78	71 20		1.03	48		.87	71 12		1.05	17 18		.93	18	75.0
73	72 26		1.03	15 4		.87	72 18		1.05	16 40		.95	72 9		1.05	18 14		1.02	17	74.1
74	73 24		1.05	56		.98	73 15		1.05	17 37		1.07	73 6		1.05	19 15		1.15	16	73.1
75	74 21		1.05	16 55		1.10	74 12		1.05	18 41		1.20	74 3		1.07	20 24		1.30	15	72.0
76	75 18		1.05	18 1		1.27	75 9		1.07	19 53		1.37	59		1.09	21 42		1.47	14	70.7
77	76 15		1.05	19 17		1.45	76 5		1.07	21 15		1.57	75 54		1.09	23 10		1.68	13	69.3
78	77 12		1.07	20 44		1.68	77 1		1.09	22 49		1.82	76 49		1.11	24 51		1.93	12	67.7
79	78 8		1.09	22 25		1.97	56		1.11	24 38		2.10	77 43		1.13	26 47		2.23	11	65.9
80	79 3		1.11	24 23			78 50		1.13	26 44			78 36		1.15	29 1		2.60	10	63.7
81	57		1.13	26 42			79 43		1.18	29 13			79 28		1.20	31 37			9	61.2
82	80 50		1.18	29 29			80 34		1.20	32 9			80 18		1.25	34 41			8	58.2
83	81 41		1.22	32 51			81 24		1.25	35 40			81 6		1.30	38 19			7	54.6
84	82 30		1.28	36 59			82 12		1.36	39 56			52		1.43	42 39			6	50.3
85	83 17		1.43	42 5			56		1.50	45 7			82 34		1.58	47 51			5	45.1
86	59		1.62	48 27			83 36		1.76	51 26			83 12		1.88	54 5			4	38.7
87	84 36		2.07	56 23			84 10		2.22	59 7			44		2.40	61 28			3	31.0
88	85 5		3.33	66 5			37		3.53	68 15			84 9		3.75	70 5			2	21.8
89	23		8.57	77 30			54		10.0	78 43			25		12.0	79 44			1	11.3
90	30			90 0			85 0			90 0			30			90 0			0	0.0
t	a	60′/Δ		b	Δ/60′		a	60′/Δ		b	Δ/60′		a	60′/Δ		b	Δ/60′			a
	$d = 4° 30'$						$d = 5° 0'$						$d = 5° 30'$							

9.514 8.777 8.144

b / B	a = 6° 0′						a = 6° 30′						a = 7° 0′						c / C	a / β
	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′		
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
0	0 0		1	6 0		0.00	0 0		1	6 30		0.00	0 0		1	7 0		0.00	90	90.0
1	1 0		1.02	0		.00	1 0		1.02	30		.00	1 0		1.02	0		.00	89	89.9
2		59	1	0		.00		59	1	30		.02		59	1	0		.02	88	89.8
3	2 59		1	0		.02	2 59		1.02	31		.00	2 59		1.02	1		.00	87	89.7
4	3 59		1.02	1		.00	3 58		1	31		.00	3 58		1	1		.02	86	89.5
5	4 58		1	1		0.02	4 58		1	31		0.02	4 58		1.02	2		0.00	85	89.4
6	5 58		1	2		.02	5 58		1.02	32		.02	5 57		1	2		.02	84	89.3
7	6 58		1.02	3		.02	6 57		1	33		.02	6 57		1.02	3		.02	83	89.2
8	7 57		1	4		.02	7 57		1	34		.02	7 56		1	4		.02	82	89.1
9	8 57		1	5		.02	8 57		1.02	35		.02	8 56		1.02	5		.02	81	89.0
10	9 57		1.02	6		0.02	9 56		1	36		0.02	9 55		1	6		0.03	80	88.9
11	10 56		1	7		.02	10 56		1.02	37		.03	10 55		1	8		.02	79	88.7
12	11 56		1	8		.02	11 55		1	39		.02	11 55		1.02	9		.03	78	88.6
13	12 56		1.02	9		.03	12 55		1.02	40		.03	12 54		1	11		.03	77	88.5
14	13 55		1	11		.03	13 54		1	42		.03	13 54		1.02	13		.03	76	88.4
15	14 55		1	13		0.02	14 54		1	44		0.03	14 53		1	15		0.03	75	88.3
16	15 55		1.02	14		.03	15 54		1.02	46		.03	15 53		1.02	17		.03	74	88.1
17	16 54		1	16		.03	16 53		1	48		.03	16 52		1	19		.03	73	88.0
18	17 54		1	18		.05	17 53		1.02	50		.03	17 52		1.02	21		.05	72	87.9
19	18 54		1.02	21		.03	18 52		1	52		.05	18 51		1	24		.05	71	87.8
20	19 53		1	23		0.03	19 52		1	55		0.03	19 51		1.02	27		0.05	70	87.6
21	20 53		1.02	25		.05	20 52		1.02	57		.05	20 50		1	30		.05	69	87.5
22	21 52		1	28		.05	21 51		1	7	0	.05	21 50		1.02	33		.05	68	87.4
23	22 52		1	31		.05	22 51		1.02	3		.05	22 49		1	36		.05	67	87.2
24	23 52		1.02	34		.05	23 50		1	6		.07	23 49		1.02	39		.07	66	87.1
25	24 51		1	37		0.05	24 50		1.02	10		0.05	24 48		1	43		0.07	65	87.0
26	25 51		1.02	40		.07	25 49		1	13		.07	25 48		1.02	47		.07	64	86.8
27	26 50		1	44		.05	26 49		1.02	17		.07	26 47		1.02	51		.07	63	86.7
28	27 50		1	47		.07	27 48		1	21		.07	27 46		1	55		.07	62	86.6
29	28 50		1.02	51		.07	28 48		1.02	25		.08	28 46		1.02	59		.08	61	86.4
30	29 49		1	55		0.07	29 47		1	30		0.07	29 45		1	8	4	0.08	60	86.3
31	30 49		1.02	59		.08	30 47		1.02	34		.08	30 45		1.02	9		.08	59	86.1
32	31 48		1	7	4	.08	31 46		1	39		.08	31 44		1.02	14		.10	58	86.0
33	32 48		1.02	9		.08	32 46		1.02	44		.08	32 43		1	20		.10	57	85.8
34	33 47		1	14		.08	33 45		1	49		.10	33 43		1.02	26		.10	56	85.6
35	34 47		1.02	19		0.08	34 45		1.02	55		0.10	34 42		1.02	32		0.10	55	85.5
36	35 46		1	24		.10	35 44		1.02	8	1	.10	35 41		1	38		.12	54	85.3
37	36 46		1.02	30		.10	36 43		1	7		.12	36 41		1.02	45		.12	53	85.1
38	37 45		1	36		.10	37 43		1.02	14		.12	37 40		1.02	52		.12	52	84.9
39	38 45		1.02	42		.12	38 42		1.02	21		.12	38 39		1	59		.12	51	84.8
40	39 44		1	49		0.12	39 41		1	28		0.12	39 39		1.02	9	6	0.13	50	84.6
41	40 44		1.02	56		.12	40 41		1.02	35		.13	40 38		1.02	14		.15	49	84.4
42	41 43		1.02	8	3	.13	41 40		1.02	43		.13	41 37		1.02	23		.15	48	84.2
43	42 42		1	11		.13	42 39		1	51		.15	42 36		1.02	32		.15	47	84.0
44	43 42		1.02	19		.13	43 39		1.02	9	0	.15	43 35		1.02	41		.17	46	83.8
45	44 41			27			44 38			9			44 34			51			45	83.5
t	a	60′/Δ	b	Δ/60′			a	60′/Δ	b	Δ/60′			a	60′/Δ	b	Δ/60′				a
	d = 6° 0′						d = 6° 30′						d = 7° 0′							

b / B	a = 6° 0′					a = 6° 30′					a = 7° 0′					c / C	a / β
	d / h	60′/Δ		t / Z	Δ/60′	d / h	60′/Δ		t / Z	Δ/60′	d / h	60′/Δ		t / Z	Δ/60′		
°	° ′			° ′		° ′			° ′		° ′			° ′		°	°
45	44 41	1		8 27	0.15	44 38	1.02		9 9	0.17	44 34	1		9 51	0.17	45	83.5
46	45 41	1.02		36	.17	45 37	1.02		19	.17	45 34	1.02		10 1	.18	44	83.3
47	46 40	1.02		46	.17	46 36	1		29	.18	46 33	1.02		12	.20	43	83.1
48	47 39	1.02		56	.17	47 36	1.02		40	.18	47 32	1.02		24	.20	42	82.8
49	48 38	1		9 6	.18	48 35	1.02		51	.20	48 31	1.02		36	.22	41	82.6
50	49 38	1.02		17	0.20	49 34	1.02		10 3	0.22	49 30	1.02		49	0.22	40	82.3
51	50 37	1.02		29	.20	50 33	1.02		16	.22	50 29	1.03		11 2	.25	39	82.0
52	51 36	1.02		41	.22	51 32	1.02		29	.23	51 27	1.02		17	.25	38	81.8
53	52 35	1.02		54	.23	52 31	1.02		43	.25	52 26	1.02		32	.27	37	81.5
54	53 34	1.02		10 8	.25	53 30	1.02		58	.27	53 25	1.02		48	.28	36	81.1
55	54 33	1.02		23	0.27	54 29	1.03		11 14	0.28	54 24	1.03		12 5	0.30	35	80.8
56	55 32	1.02		39	.27	55 27	1.02		31	.30	55 22	1.02		23	.32	34	80.5
57	56 31	1.02		55	.30	56 26	1.02		49	.32	56 21	1.03		42	.35	33	80.1
58	57 30	1.02		11 13	.32	57 25	1.02		12 8	.33	57 19	1.02		13 3	.37	32	79.7
59	58 29	1.02		32	.33	58 24	1.03		28	.37	58 18	1.03		25	.38	31	79.3
60	59 28	1.03		52	0.37	59 22	1.02		50	0.38	59 16	1.03		48	0.42	30	78.9
61	60 26	1.02		12 14	.38	60 21	1.03		13 13	.42	60 14	1.03		14 13	.43	29	78.5
62	61 25	1.03		37	.42	61 19	1.03		38	.45	61 12	1.03		39	.48	28	78.0
63	62 23	1.02		13 2	.45	62 17	1.03		14 5	.48	62 10	1.03		15 8	.52	27	77.5
64	63 22	1.03		29	.48	63 15	1.03		34	.52	63 8	1.03		39	.55	26	76.9
65	64 20	1.03		58	0.52	64 13	1.03		15 5	0.57	64 6	1.03		16 12	0.60	25	76.4
66	65 18	1.03		14 29	.57	65 11	1.03		39	.60	65 4	1.05		48	.65	24	75.7
67	66 16	1.03		15 3	.62	66 9	1.05		16 15	.67	66 1	1.05		17 27	.70	23	75.1
68	67 14	1.03		40	.68	67 6	1.03		55	.72	58	1.05		18 9	.77	22	74.3
69	68 12	1.05		16 21	.73	68 4	1.05		17 38	.78	67 55	1.05		55	.83	21	73.6
70	69 9	1.05		17 5	0.82	69 1	1.05		18 25	0.87	68 52	1.07		19 45	0.92	20	72.7
71	70 6	1.05		54	.88	58	1.07		19 17	.95	69 48	1.07		20 40	1.00	19	71.8
72	71 3	1.05		18 47	.98	70 54	1.07		20 14	1.05	70 44	1.09		21 40	1.12	18	70.8
73	72 0	1.07		19 46	1.10	71 50	1.07		21 17	1.17	71 39	1.09		22 47	1.23	17	69.7
74	56	1.07		20 52	1.23	72 46	1.09		22 27	1.30	72 34	1.09		24 1	1.37	16	68.5
75	73 52	1.09		22 6	1.38	73 41	1.09		23 45	1.47	73 29	1.11		25 23	1.53	15	67.1
76	74 47	1.09		23 29	1.57	74 36	1.11		25 13	1.65	74 23	1.13		26 55	1.72	14	65.6
77	75 42	1.11		25 3	1.77	75 30	1.13		26 52	1.85	75 16	1.15		28 38	1.93	13	63.9
78	76 36	1.13		26 49	2.03	76 23	1.15		28 43	2.12	76 8	1.18		30 34	2.20	12	62.0
79	77 29	1.15		28 51	2.33	77 15	1.18		30 50	2.43	59	1.20		32 46	2.50	11	59.8
80	78 21	1.18		31 11	2.72	78 6	1.22		33 16	2.80	77 49	1.25		35 16	2.87	10	57.3
81	79 12	1.22		33 54		55	1.28		36 4		78 37	1.30		38 8		9	54.4
82	80 1	1.30		37 4		79 42	1.30		39 18		79 23	1.36		41 25		8	51.1
83	47	1.36		40 47		80 28	1.43		43 4		80 7	1.50		45 13		7	47.3
84	81 31	1.46		45 9		81 10	1.58		47 28		47	1.62		49 36		6	42.9
85	82 12	1.67		50 20		48	1.76		52 35		81 24	1.82		54 38		5	37.7
86	48	2.00		56 26		82 22	2.07		58 31		57	2.31		60 24		4	31.7
87	83 18	2.61		63 32		51	2.86		65 20		82 23	3.00		66 55		3	24.8
88	41	4.29		71 38		83 12	4.62		72 58		43	4.62		74 8		2	17.1
89	55	12.0		80 34		25	12.0		81 17		56	15.0		81 55		1	8.8
90	84 0			90 0		30			90 0		83 0			90 0		0	0.0
t	a	60′/Δ		b	Δ/60′	a	60′/Δ		b	Δ/60′	a	60′/Δ		b	Δ/60′		a
	d = 6° 0′					d = 6° 30′					d = 7° 0′						

7.596 7.115 6.691

b / B	a = 7° 30′					a = 8° 0′					a = 8° 30′					c / C	a / β
	h \ d		60′/Δ	Z \ t	Δ/60′	h \ d		60′/Δ	Z \ t	Δ/60′	h \ d		60′/Δ	Z \ t	Δ/60′		
	°	′		° ′		°	′		° ′		°	′		° ′		°	°
0	0	0	1.02	7 30	0.00	0	0	1.02	8 0	0.00	0	0	1.02	8 30	0.00	90	90.0
1		59	1	30	.00		59	1	0	.00		59	1	30	.00	89	89.9
2	1	59	1.02	30	.02	1	59	1.02	0	.02	1	59	1.02	30	.02	88	89.7
3	2	58	1	31	.00	2	58	1	1	.00	2	58	1.02	31	.00	87	89.6
4	3	58	1.02	31	.02	3	58	1.02	1	.02	3	57	1	31	.02	86	89.4
5	4	57	1	32	0.00	4	57	1.02	2	0.02	4	57	1.02	32	0.02	85	89.3
6	5	57	1.02	32	.02	5	56	1	3	.02	5	56	1.02	33	.02	84	89.2
7	6	56	1	33	.02	6	56	1.02	4	.02	6	55	1	34	.02	83	89.0
8	7	56	1.02	34	.02	7	55	1	5	.02	7	55	1.02	35	.02	82	88.9
9	8	55	1	35	.03	8	55	1.02	6	.02	8	54	1.02	36	.03	81	88.7
10	9	55	1.02	37	0.02	9	54	1.02	7	0.03	9	53	1	38	0.02	80	88.6
11	10	54	1	38	.03	10	53	1	9	.03	10	53	1.02	39	.03	79	88.5
12	11	54	1.02	40	.03	11	53	1.02	11	.03	11	52	1.02	41	.03	78	88.3
13	12	53	1	42	.03	12	52	1	13	.03	12	51	1	43	.03	77	88.2
14	13	53	1.02	44	.03	13	52	1.02	15	.03	13	51	1.02	45	.05	76	88.0
15	14	52	1	46	0.03	14	51	1.02	17	0.03	14	50	1.02	48	0.03	75	87.9
16	15	52	1.02	48	.03	15	50	1	19	.05	15	49	1.02	50	.05	74	87.7
17	16	51	1.02	50	.05	16	50	1.02	22	.03	16	48	1	53	.05	73	87.6
18	17	50	1	53	.05	17	49	1.02	24	.05	17	48	1.02	56	.05	72	87.4
19	18	50	1.02	56	.05	18	48	1	27	.05	18	47	1.02	59	.05	71	87.3
20	19	49	1	59	0.05	19	48	1.02	30	0.07	19	46	1	9 2	0.07	70	87.1
21	20	49	1.02	8 2	.05	20	47	1.02	34	.05	20	46	1.02	6	.05	69	86.9
22	21	48	1	5	.05	21	46	1	37	.07	21	45	1.02	9	.07	68	86.8
23	22	48	1.02	8	.07	22	46	1.02	41	.07	22	44	1.02	13	.07	67	86.6
24	23	47	1.02	12	.07	23	45	1.02	45	.07	23	43	1.02	17	.08	66	86.5
25	24	46	1	16	0.07	24	44	1	49	0.07	24	42	1	22	0.07	65	86.3
26	25	46	1.02	20	.07	25	44	1.02	53	.08	25	42	1.02	26	.08	64	86.1
27	26	45	1.02	24	.08	26	43	1.02	58	.08	26	41	1.02	31	.08	63	85.9
28	27	44	1	29	.08	27	42	1.02	9 3	.08	27	40	1.02	36	.10	62	85.8
29	28	44	1.02	34	.08	28	41	1	8	.08	28	39	1.02	42	.10	61	85.6
30	29	43	1.02	39	0.08	29	41	1.02	13	0.10	29	38	1.02	48	0.10	60	85.4
31	30	42	1	44	.08	30	40	1.02	19	.10	30	37	1.02	54	.10	59	85.2
32	31	42	1.02	49	.10	31	39	1.02	25	.10	31	36	1	10 0	.10	58	85.0
33	32	41	1.02	55	.10	32	38	1.02	31	.10	32	36	1.02	6	.12	57	84.8
34	33	40	1.02	9 1	.12	33	37	1	37	.12	33	35	1.02	13	.12	56	84.6
35	34	39	1	8	0.12	34	37	1.02	44	0.12	34	34	1.02	20	0.13	55	84.4
36	35	39	1.02	15	.12	35	36	1.02	51	.13	35	33	1.02	28	.13	54	84.2
37	36	38	1.02	22	.12	36	35	1.02	59	.13	36	32	1.02	36	.13	53	84.0
38	37	37	1.02	29	.13	37	34	1.02	10 7	.13	37	31	1.02	44	.15	52	83.8
39	38	36	1.02	37	.13	38	33	1.02	15	.15	38	30	1.03	53	.15	51	83.5
40	39	35	1	45	0.15	39	32	1.02	24	0.15	39	28	1.02	11 2	0.17	50	83.3
41	40	35	1.02	54	.15	40	31	1.02	33	.17	40	27	1.02	12	.17	49	83.1
42	41	34	1.02	10 3	.15	41	30	1.02	43	.17	41	26	1.02	22	.18	48	82.9
43	42	33	1.02	12	.17	42	29	1.02	53	.17	42	25	1.02	33	.18	47	82.6
44	43	32	1.02	22	.18	43	28	1.02	11 3	.18	43	24	1.03	44	.20	46	82.3
45	44	31		33		44	27		14		44	22		56		45	82.1

t	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′		a
	d = 7° 30′				d = 8° 0′				d = 8° 30′					

b / B	a = 7° 30′						a = 8° 0′						a = 8° 30′						c / C	a / β
	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′		
°	°	′		°	′		°	′		°	′		°	′		°	′		°	°
45	44	31	1.02	10	33	0.18	44	27	1.02	11	14	0.20	44	22	1.02	11	56	0.22	45	82.1
46	45	30	1.02		44	.20	45	26	1.03		26	.22	45	21	1.02	12	9	.22	44	81.8
47	46	29	1.02		56	.20	46	24	1.02		39	.22	46	20	1.03		22	.23	43	81.5
48	47	28	1.03	11	8	.22	47	23	1.02		52	.23	47	18	1.02		36	.23	42	81.2
49	48	26	1.02		21	.23	48	22	1.03	12	6	.23	48	17	1.03		50	.25	41	80.9
50	49	25	1.02		35	0.23	49	20	1.02		20	0.25	49	15	1.02	13	5	0.28	40	80.6
51	50	24	1.02		49	.25	50	19	1.02		35	.28	50	14	1.03		22	.28	39	80.2
52	51	23	1.03	12	4	.27	51	18	1.03		52	.28	51	12	1.03		39	.30	38	79.9
53	52	21	1.02		20	.28	52	16	1.03	13	9	.30	52	10	1.02		57	.32	37	79.5
54	53	20	1.03		37	.32	53	14	1.02		27	.32	53	9	1.03	14	16	.33	36	79.2
55	54	18	1.02		56	0.32	54	13	1.03		46	0.33	54	7	1.03		36	0.37	35	78.8
56	55	17	1.03	13	15	.33	55	11	1.03	14	6	.37	55	5	1.03		58	.38	34	78.3
57	56	15	1.03		35	.37	56	9	1.03		28	.38	56	3	1.05	15	21	.40	33	77.9
58	57	13	1.02		57	.38	57	7	1.03		51	.42	57	0	1.03		45	.43	32	77.4
59	58	12	1.03	14	20	.42	58	5	1.03	15	16	.43		58	1.03	16	11	.47	31	77.0
60	59	10	1.03		45	0.45	59	3	1.03		42	0.47	58	56	1.05		39	0.48	30	76.4
61	60	8	1.05	15	12	.47	60	1	1.05	16	10	.50	59	53	1.05	17	8	.52	29	75.9
62	61	5	1.03		40	.50		58	1.03		40	.53	60	50	1.05		39	.57	28	75.3
63	62	3	1.03	16	10	.55	61	56	1.05	17	12	.58	61	47	1.05	18	13	.62	27	74.7
64	63	1	1.05		43	.58	62	53	1.05		47	.62	62	44	1.05		50	.65	26	74.1
65		58	1.05	17	18	0.63	63	50	1.05	18	24	0.67	63	41	1.07	19	29	0.70	25	73.4
66	64	55	1.05		56	.68	64	47	1.07	19	4	.72	64	37	1.07	20	11	.75	24	72.6
67	65	52	1.05	18	37	.75	65	43	1.07		47	.78	65	33	1.07		56	.82	23	71.8
68	66	49	1.05	19	22	.80	66	39	1.07	20	34	.85	66	29	1.07	21	45	.88	22	71.0
69	67	46	1.07	20	10	.88	67	35	1.07	21	25	.92	67	25	1.09	22	38	.97	21	70.1
70	68	42	1.07	21	3	0.97	68	31	1.09	22	20	1.02	68	20	1.09	23	36	1.05	20	69.1
71	69	38	1.09	22	1	1.07	69	26	1.09	23	21	1.10	69	15	1.11	24	39	1.15	19	68.0
72	70	33	1.09	23	5	1.17	70	21	1.09	24	27	1.22	70	9	1.11	25	48	1.27	18	66.8
73	71	28	1.11	24	15	1.28	71	16	1.11	25	40	1.35	71	3	1.13	27	4	1.40	17	65.5
74	72	22	1.11	25	32	1.43	72	10	1.13	27	1	1.48		56	1.15	28	28	1.53	16	64.1
75	73	16	1.13	26	58	1.58	73	3	1.15	28	30	1.65	72	48	1.15	30	0	1.70	15	62.6
76	74	9	1.15	28	33	1.78		55	1.18	30	9	1.85	73	40	1.20	31	42	1.90	14	60.8
77	75	1	1.15	30	20	2.00	74	46	1.18	32	0	2.07	74	30	1.20	33	36	2.12	13	58.9
78		53	1.20	32	20	2.27	75	37	1.22	34	4	2.32	75	20	1.25	35	43	2.35	12	56.8
79	76	43	1.25	34	36	2.57	76	26	1.28	36	23	2.60	76	8	1.30	38	4	2.65	11	54.4
80	77	31	1.28	37	10	2.92	77	13	1.30	38	59	2.95		54	1.33	40	43	2.97	10	51.7
81	78	18	1.33	40	5	3.33		59	1.40	41	56	3.35	77	39	1.43	43	41	3.35	9	48.7
82	79	3	1.43	43	25		78	42	1.46	45	17		78	21	1.54	47	2	3.77	8	45.3
83		45	1.54	47	13		79	23	1.58	49	4		79	0	1.62	50	48		7	41.4
84	80	24	1.67	51	33		80	1	1.76	53	22			37	1.88	55	2		6	37.1
85	81	0	2.00	56	30			35	2.07	58	12		80	9	2.14	59	45		5	32.2
86		30	2.31	62	5		81	4	2.50	63	36			37	2.73	64	59		4	26.7
87		56	3.33	68	19			28	3.53	69	35			59	3.53	70	42		3	20.6
88	82	14	5.00	75	9			45	5.45	76	3		81	16	5.45	76	51		2	14.1
89		26	15.0	82	27			56	15.0	82	55			27	20.0	83	20		1	7.1
90		30		90	0		82	0		90	0			30		90	0		0	0.0
t	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′		a
	d = 7° 30′						d = 8° 0′						d = 8° 30′							

b / B	a = 9° 0′						a = 9° 30′						a = 10° 0′						c / C	a / β
	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′		
	°	′		°	′		°	′		°	′		°	′		°	′			
0	0	0	1.02	9	0	0.00	0	0	1.02	9	30	0.00	0	0	1.02	10	0	0.00	90	90.0
1		59	1		0	.00		59	1.02		30	.00		59	1.02		0	.00	89	89.8
2	1	59	1.02		0	.02	1	58	1.02		30	.02	1	58	1.02		0	.02	88	89.7
3	2	58	1.02		1	.00	2	57	1		31	.00	2	57	1.02		1	.00	87	89.5
4	3	57	1.02		1	.02	3	57	1.02		31	.02	3	56	1.02		1	.02	86	89.3
5	4	56	1		2	0.02	4	56	1.02		32	0.02	4	55	1		2	0.02	85	89.2
6	5	56	1.02		3	.02	5	55	1.02		33	.02	5	55	1.02		3	.02	84	89.0
7	6	55	1.02		4	.02	6	54	1.02		34	.02	6	54	1.02		4	.03	83	88.8
8	7	54	1.02		5	.03	7	53	1		35	.03	7	53	1.02		6	.02	82	88.7
9	8	53	1		7	.02	8	53	1.02		37	.03	8	52	1.02		7	.03	81	88.5
10	9	53	1.02		8	0.03	9	52	1.02		39	0.03	9	51	1.02		9	0.03	80	88.3
11	10	52	1.02		10	.03	10	51	1.02		41	.03	10	50	1.02		11	.03	79	88.1
12	11	51	1.02		12	.03	11	50	1.02		43	.03	11	49	1.02		13	.03	78	88.0
13	12	50	1.02		14	.03	12	49	1.02		45	.03	12	48	1.02		15	.05	77	87.8
14	13	49	1		16	.05	13	48	1.02		47	.05	13	47	1.02		18	.05	76	87.6
15	14	49	1.02		19	0.03	14	47	1.02		50	0.05	14	46	1.02		21	0.05	75	87.5
16	15	48	1.02		21	.05	15	46	1		53	.05	15	45	1.02		24	.05	74	87.3
17	16	47	1.02		24	.05	16	46	1.02		56	.05	16	44	1.02		27	.05	73	87.1
18	17	46	1.02		27	.05	17	45	1.02		59	.05	17	43	1.02		30	.07	72	86.9
19	18	45	1		30	.07	18	44	1.02	10	2	.07	18	42	1.02		34	.07	71	86.7
20	19	45	1.02		34	0.07	19	43	1.02		6	0.07	19	41	1.02		38	0.07	70	86.6
21	20	44	1.02		38	.07	20	42	1.02		10	.07	20	40	1.02		42	.07	69	86.4
22	21	43	1.02		42	.07	21	41	1.02		14	.07	21	39	1.02		46	.08	68	86.2
23	22	42	1.02		46	.07	22	40	1.02		18	.08	22	38	1.02		51	.08	67	86.0
24	23	41	1.02		50	.08	23	39	1.02		23	.08	23	37	1.02		56	.08	66	85.8
25	24	40	1.02		55	0.08	24	38	1.02		28	0.08	24	36	1.02	11	1	0.08	65	85.6
26	25	39	1.02	10	0	.08	25	37	1.02		33	.08	25	35	1.03		6	.10	64	85.4
27	26	38	1		5	.08	26	36	1.02		38	.10	26	33	1.02		12	.10	63	85.2
28	27	38	1.02		10	.10	27	35	1.02		44	.10	27	32	1.02		18	.10	62	85.0
29	28	37	1.02		16	.10	28	34	1.02		50	.10	28	31	1.02		24	.12	61	84.8
30	29	36	1.02		22	0.10	29	33	1.02		56	0.12	29	30	1.02		31	0.12	60	84.6
31	30	35	1.02		28	.12	30	32	1.02	11	3	.12	30	29	1.03		38	.12	59	84.3
32	31	34	1.02		35	.12	31	31	1.03		10	.12	31	27	1.02		45	.12	58	84.1
33	32	33	1.02		42	.12	32	29	1.02		17	.13	32	26	1.02		52	.13	57	83.9
34	33	32	1.03		49	.13	33	28	1.02		25	.13	33	25	1.02	12	0	.15	56	83.6
35	34	30	1.02		57	0.13	34	27	1.02		33	0.13	34	24	1.03		9	0.15	55	83.4
36	35	29	1.02	11	5	.13	35	26	1.02		41	.15	35	22	1.02		18	.15	54	83.2
37	36	28	1.02		13	.15	36	25	1.03		50	.15	36	21	1.03		27	.17	53	82.9
38	37	27	1.02		22	.15	37	23	1.02		59	.17	37	19	1.02		37	.17	52	82.7
39	38	26	1.02		31	.17	38	22	1.02	12	9	.17	38	18	1.03		47	.18	51	82.4
40	39	25	1.03		41	0.17	39	21	1.03		19	0.18	39	16	1.02		58	0.18	50	82.1
41	40	23	1.02		51	.18	40	19	1.02		30	.18	40	15	1.03	13	9	.20	49	81.8
42	41	22	1.02	12	2	.18	41	18	1.03		41	.20	41	13	1.02		21	.20	48	81.5
43	42	21	1.03		13	.20	42	16	1.02		53	.22	42	12	1.03		33	.22	47	81.3
44	43	19	1.02		25	.22	43	15	1.03	13	6	.22	43	10	1.03		46	.23	46	80.9
45	44	18			38		44	13			19		44	8		14	0		45	80.6
t	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′		α
	d = 9° 0′						d = 9° 30′						d = 10° 0′							

B	a = 9° 0′ h	d	60′/Δ	Z	t	Δ/60′	a = 9° 30′ h	d	60′/Δ	Z	t	Δ/60′	a = 10° 0′ h	d	60′/Δ	Z	t	Δ/60′	C	β
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
45	44 18		1.03	12 38		0.22	44 13		1.02	13 19		0.23	44 8		1.03	14 0		0.25	45	80.6
46	45 16		1.02		51	.23	45 12		1.03		33	.23	45 6		1.03		15	.25	44	80.3
47	46 15		1.03	13 5		.23	46 10		1.03		47	.25	46 4		1.03		30	.27	43	80.0
48	47 13		1.02		19	.25	47 8		1.03	14 2		.27	47 2		1.03		46	.28	42	79.6
49	48 12		1.03		34	.28	48 6		1.03		18	.28	48 0		1.03	15 3		.28	41	79.3
50	49 10		1.03		51	0.28	49 4		1.03		35	0.30		58	1.03		20	0.32	40	78.9
51	50 8		1.03	14 8		.30	50 2		1.03		53	.32	49	56	1.03		39	.33	39	78.5
52	51 6		1.03		26	.32	51 0		1.03	15 12		.33	50	54	1.03		59	.35	38	78.1
53	52 4		1.03		45	.33		58	1.03		32	.35	51	52	1.05	16 20		.37	37	77.6
54	53 2		1.03	15 5		.35	52	56	1.03		53	.38	52	49	1.03		42	.38	36	77.2
55	54 0		1.03		26	0.38	53	54	1.05	16 16		0.40	53	47	1.05	17 5		0.42	35	76.7
56		58	1.03		49	.40	54	51	1.03		40	.42	54	44	1.05		30	.43	34	76.2
57	55 56		1.05	16 13		.43	55	49	1.05	17 5		.45	55	41	1.05		56	.47	33	75.7
58	56 53		1.03		39	.45	56	46	1.05		32	.47	56	38	1.05	18 24		.50	32	75.2
59	57 51		1.05	17 6		.48	57	43	1.05	18 0		.50	57	35	1.05		54	.53	31	74.6
60	58 48		1.05		35	0.52	58	40	1.05		30	0.55	58	32	1.07	19 26		0.55	30	74.0
61	59 45		1.05	18 6		.55	59	37	1.07	19 3		.57	59	28	1.07		59	.60	29	73.4
62	60 42		1.05		39	.58	60	33	1.05		37	.62	60	24	1.07	20 35		.65	28	72.8
63	61 39		1.05	19 14		.63	61	30	1.07	20 14		.67	61	20	1.07	21 14		.68	27	72.1
64	62 36		1.07		52	.68	62	26	1.07		54	.70	62	16	1.07		55	.73	26	71.3
65	63 32		1.07	20 33		0.73	63	22	1.07	21 36		0.77	63	12	1.09	22 39		0.78	25	70.5
66	64 28		1.07	21 17		.78	64	18	1.09	22 22		.82	64	7	1.09	23 26		.85	24	69.8
67	65 24		1.09	22 4		.85	65	13	1.09	23 11		.88	65	2	1.11	24 17		.92	23	68.8
68	66 19		1.09		55	.93	66	8	1.11	24 4		.97		56	1.11	25 12		1.00	22	67.8
69	67 14		1.09	23 51		1.00	67	2	1.11	25 2		1.03	66	50	1.11	26 12		1.07	21	66.7
70	68 9		1.11	24 51		1.08		56	1.11	26 4		1.13	67	44	1.13	27 16		1.17	20	65.6
71	69 3		1.11	25 56		1.20	68	50	1.13	27 12		1.23	68	37	1.15	28 26		1.28	19	64.4
72		57	1.13	27 8		1.32	69	43	1.13	28 26		1.35	69	29	1.15	29 43		1.38	18	63.1
73	70 50		1.15	28 27		1.43	70	36	1.18	29 47		1.48	70	21	1.18	31 6		1.50	17	61.6
74	71 42		1.15	29 53		1.58	71	27	1.18	31 16		1.62	71	12	1.20	32 36		1.67	16	60.1
75	72 34		1.20	31 28		1.75	72	18	1.20	32 53		1.78	72	2	1.22	34 16		1.82	15	58.4
76	73 24		1.20	33 13		1.93	73	8	1.22	34 40		1.98		51	1.25	36 5		2.00	14	56.5
77	74 14		1.25	35 9		2.15		57	1.28	36 39		2.18	73	39	1.28	38 5		2.22	13	54.4
78	75 2		1.28	37 18		2.40	74	44	1.30	38 50		2.42	74	26	1.33	40 18		2.43	12	52.2
79		49	1.30	39 42		2.67	75	30	1.36	41 15		2.68	75	11	1.40	42 44		2.70	11	49.7
80	76 35		1.40	42 22		2.98	76	14	1.40	43 56		3.00		54	1.46	45 26		2.98	10	46.9
81	77 18		1.46	45 21		3.35		57	1.54	46 56		3.32	76	35	1.58	48 25		3.30	9	43.8
82		59	1.58	48 42		3.72	77	36	1.62	50 15		3.68	77	13	1.67	51 43		3.63	8	40.4
83	78 37		1.71	52 25			78	13	1.76	53 56		4.08		49	1.88	55 21		3.98	7	36.6
84	79 12		1.94	56 35				47	2.00	58 1			78	21	2.07	59 20			6	32.5
85		43	2.31	61 11			79	17	2.40	62 29				50	2.50	63 42			5	27.9
86	80 9		2.73	66 14				42	2.86	67 22			79	14	3.00	68 25			4	23.0
87		31	3.75	71 43			80	3	4.00	72 38				34	4.29	73 28			3	17.6
88		47	6.00	77 34				18	6.67	78 13				48	6.67	78 48			2	11.9
89		57	20.0	83 43				27	20.0	84 3				57	20.0	84 21			1	6.0
90	81 0			90 0				30		90 0			80 0			90 0			0	0.0
t	a	60′/Δ		b	Δ/60′		a	60′/Δ		b	Δ/60′		a	60′/Δ		b	Δ/60′			
	d = 9° 0′						d = 9° 30′						d = 10° 0′							

b / B	a = 10° 30′						a = 11° 0′						a = 11° 30′						c / C	a / β
	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′		
	°	′		°	′		°	′		°	′		°	′		°	′			
0	0	0	1.02	10	30	0.00	0	0	1.02	11	0	0.00	0	0	1.02	11	30	0.00	**90**	90.0
1		59	1.02		30	.00		59	1.02		0	.00		59	1.02		30	.00	89	89.8
2	1	58	1.02		30	.02	1	58	1.02		0	.02	1	58	1.03		30	.02	88	89.6
3	2	57	1.02		31	.02	2	57	1.02		1	.02	2	56	1.02		31	.02	87	89.4
4	3	56	1.02		32	.00	3	56	1.03		2	.02	3	55	1.02		32	.02	86	89.2
5	4	55	1.02		32	0.02	4	54	1.02		3	0.02	4	54	1.02		33	0.02	85	89.0
6	5	54	1.02		33	.03	5	53	1.02		4	.02	5	53	1.02		34	.02	84	88.9
7	6	53	1.02		35	.02	6	52	1.02		5	.02	6	52	1.03		35	.03	83	88.7
8	7	52	1.02		36	.03	7	51	1.02		6	.03	7	50	1.02		37	.02	82	88.5
9	8	51	1.02		38	.03	8	50	1.02		8	.03	8	49	1.02		38	.03	81	88.3
10	9	50	1.02		40	0.03	9	49	1.02		10	0.03	9	48	1.02		40	0.03	80	88.1
11	10	49	1.02		42	.03	10	48	1.02		12	.03	10	47	1.03		42	.05	79	87.9
12	11	48	1.02		44	.03	11	47	1.03		14	.05	11	45	1.02		45	.05	78	87.7
13	12	47	1.02		46	.05	12	45	1.02		17	.05	12	44	1.02		48	.05	77	87.5
14	13	46	1.02		49	.05	13	44	1.02		20	.05	13	43	1.02		51	.05	76	87.3
15	14	45	1.02		52	0.05	14	43	1.02		23	0.05	14	42	1.03		54	0.05	**75**	87.1
16	15	44	1.03		55	.05	15	42	1.02		26	.05	15	40	1.02		57	.07	74	86.9
17	16	42	1.02		58	.07	16	41	1.03		29	.07	16	39	1.02	12	1	.07	73	86.7
18	17	41	1.02	11	2	.07	17	39	1.02		33	.07	17	38	1.03		5	.07	72	86.5
19	18	40	1.02		6	.07	18	38	1.02		37	.07	18	36	1.02		9	.07	71	86.2
20	19	39	1.02		10	0.07	19	37	1.02		41	0.08	19	35	1.02		13	0.08	**70**	86.0
21	20	38	1.02		14	.07	20	36	1.02		46	.08	20	34	1.03		18	.08	69	85.8
22	21	37	1.02		18	.08	21	35	1.03		51	.08	21	32	1.02		23	.08	68	85.6
23	22	36	1.03		23	.08	22	33	1.02		56	.08	22	31	1.03		28	.08	67	85.4
24	23	34	1.02		28	.08	23	32	1.02	12	1	.08	23	29	1.02		33	.10	66	85.1
25	24	33	1.02		33	0.10	24	31	1.03		6	0.10	24	28	1.03		39	0.10	**65**	84.9
26	25	32	1.02		39	.10	25	29	1.02		12	.10	25	26	1.02		45	.12	64	84.7
27	26	31	1.03		45	.10	26	28	1.02		18	.12	26	25	1.03		52	.12	63	84.5
28	27	29	1.02		51	.12	27	27	1.03		25	.12	27	23	1.02		59	.12	62	84.2
29	28	28	1.02		58	.12	28	25	1.02		32	.12	28	22	1.03	13	6	.12	61	84.0
30	29	27	1.02	12	5	0.12	29	24	1.03		39	0.13	29	20	1.02		13	0.13	**60**	83.7
31	30	26	1.03		12	.13	30	22	1.02		47	.13	30	19	1.03		21	.13	59	83.5
32	31	24	1.02		20	.13	31	21	1.03		55	.13	31	17	1.03		29	.15	58	83.2
33	32	23	1.03		28	.13	32	19	1.02	13	3	.15	32	15	1.02		38	.15	57	82.9
34	33	21	1.02		36	.15	33	18	1.03		12	.15	33	14	1.03		47	.17	56	82.7
35	34	20	1.03		45	0.15	34	16	1.03		21	0.17	34	12	1.03		57	0.17	**55**	82.4
36	35	18	1.02		54	.17	35	14	1.02		31	.17	35	10	1.03	14	7	.18	54	82.1
37	36	17	1.03	13	4	.17	36	13	1.03		41	.17	36	8	1.03		18	.18	53	81.8
38	37	15	1.02		14	.18	37	11	1.03		51	.18	37	6	1.03		29	.18	52	81.5
39	38	14	1.03		25	.18	38	9	1.03	14	2	.20	38	4	1.03		40	.20	51	81.2
40	39	12	1.03		36	0.20	39	7	1.03		14	0.22	39	2	1.03		52	0.22	**50**	80.9
41	40	10	1.02		48	.20	40	5	1.03		27	.22	40	0	1.03	15	5	.23	49	80.6
42	41	9	1.03	14	0	.22	41	3	1.03		40	.22		58	1.03		19	.23	48	80.3
43	42	7	1.03		13	.23	42	1	1.03		53	.23	41	56	1.03		33	.25	47	79.9
44	43	5	1.03		27	.23		59	1.03	15	7	.25	42	54	1.03		48	.25	46	79.6
45	44	3			41		43	57			22		43	52			16	3	**45**	79.2
t	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′		a
	d = 10° 30′						d = 11° 0′						d = 11° 30′							

5.396 5.145 4.915

b / B	a = 10° 30′						a = 11° 0′						a = 11° 30′						c / C	a / β
	h \ d	60′/Δ		Z \ t	Δ/60′		h \ d	60′/Δ		Z \ t	Δ/60′		h \ d	60′/Δ		Z \ t	Δ/60′			
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
45	44 3	1.03		14 41	0.25		43 57	1.03		15 22	0.27		43 52	1.05		16 3	0.28		45	79.2
46	45 1	1.03		56	.27		44 55	1.03		38	.28		44 49	1.03		20	.28		44	78.8
47	59	1.03		15 12	.28		45 53	1.03		55	.28		45 47	1.05		37	.30		43	78.4
48	46 57	1.05		29	.30		46 51	1.05		16 12	.30		46 44	1.03		55	.32		42	78.0
49	47 54	1.03		47	.30		47 48	1.03		30	.33		47 42	1.05		17 14	.33		41	77.6
50	48 52	1.03		16 5	0.33		48 46	1.05		50	0.33		48 39	1.05		34	0.35		40	77.2
51	49 50	1.05		25	.33		49 43	1.05		17 10	.35		49 36	1.05		55	.37		39	76.7
52	50 47	1.03		45	.37		50 40	1.05		31	.38		50 33	1.05		18 17	.40		38	76.3
53	51 45	1.05		17 7	.38		51 37	1.05		54	.40		51 30	1.05		41	.42		37	75.8
54	52 42	1.05		30	.40		52 34	1.05		18 18	.42		52 27	1.07		19 6	.43		36	75.3
55	53 39	1.05		54	0.43		53 31	1.05		43	0.45		53 23	1.05		32	0.47		35	74.8
56	54 36	1.05		18 20	.47		54 28	1.05		19 10	.48		54 20	1.07		20 0	.48		34	74.2
57	55 33	1.05		48	.48		55 25	1.07		39	.50		55 16	1.07		29	.52		33	73.6
58	56 30	1.05		19 17	.50		56 21	1.07		20 9	.53		56 12	1.07		21 0	.55		32	73.0
59	57 27	1.07		47	.55		57 17	1.07		41	.57		57 8	1.07		33	.58		31	72.4
60	58 23	1.07		20 20	0.58		58 13	1.07		21 15	0.60		58 4	1.09		22 8	0.63		30	71.7
61	59 19	1.07		55	.63		59 9	1.07		51	.65		59	1.09		46	.67		29	71.0
62	60 15	1.07		21 33	.65		60 5	1.09		22 30	.68		59 54	1.09		23 26	.70		28	70.3
63	61 11	1.09		22 12	.72		61 0	1.09		23 11	.73		60 49	1.09		24 8	.77		27	69.5
64	62 6	1.09		55	.77		55	1.09		55	.78		61 44	1.11		54	.80		26	68.6
65	63 1	1.09		23 41	0.82		62 50	1.11		24 42	0.85		62 38	1.11		25 42	0.87		25	67.7
66	56	1.11		24 30	.88		63 44	1.11		25 33	.90		63 32	1.11		26 34	.93		24	66.8
67	64 50	1.11		25 23	.95		64 38	1.11		26 27	.98		64 26	1.13		27 30	1.00		23	65.8
68	65 44	1.11		26 20	1.02		65 32	1.13		27 26	1.05		65 19	1.15		28 30	1.08		22	64.7
69	66 38	1.13		27 21	1.10		66 25	1.15		28 29	1.13		66 11	1.15		29 35	1.17		21	63.6
70	67 31	1.15		28 27	1.20		67 17	1.15		29 37	1.22		67 3	1.18		30 45	1.25		20	62.3
71	68 23	1.15		29 39	1.30		68 9	1.18		30 50	1.33		54	1.18		32 0	1.37		19	61.0
72	69 15	1.18		30 57	1.42		69 0	1.20		32 10	1.45		68 45	1.22		33 22	1.47		18	59.6
73	70 6	1.20		32 22	1.55		50	1.20		33 37	1.58		69 34	1.22		34 50	1.60		17	58.0
74	56	1.20		33 55	1.68		70 40	1.25		35 12	1.72		70 23	1.25		36 26	1.73		16	56.4
75	71 46	1.25		35 36	1.85		71 28	1.25		36 55	1.87		71 11	1.30		38 10	1.90		15	54.5
76	72 34	1.28		37 27	2.03		72 16	1.30		38 47	2.05		57	1.30		40 4	2.07		14	52.6
77	73 21	1.33		39 29	2.23		73 2	1.33		40 50	2.23		72 43	1.40		42 8	2.25		13	50.4
78	74 6	1.36		41 43	2.45		47	1.40		43 4	2.47		73 26	1.43		44 23	2.45		12	48.1
79	50	1.43		44 10	2.70		74 30	1.46		45 32	2.68		74 8	1.50		46 50	2.68		11	45.5
80	75 32	1.50		46 52	2.97		75 11	1.58		48 13	2.95		48	1.58		49 31	2.93		10	42.7
81	76 12	1.58		49 50	3.27		49	1.62		51 10	3.23		75 26	1.71		52 27	3.18		9	39.7
82	50	1.76		53 6	3.57		76 26	1.82		54 24	3.52		76 1	1.82		55 38	3.45		8	36.4
83	77 24	1.94		56 40	3.92		59	2.00		57 55	3.82		34	2.07		59 5	3.73		7	32.8
84	55	2.14		60 35	4.23		77 29	2.22		61 44	4.12		77 3	2.40		62 49	4.00		6	28.8
85	78 23	2.61		64 49			56	2.73		65 51	4.42		28	2.73		66 49	4.27		5	24.6
86	46	3.16		69 23			78 18	3.33		70 16			50	3.53		71 5	4.48		4	20.1
87	79 5	4.29		74 14			36	4.62		74 56			78 7	4.62		75 34			3	15.4
88	19	7.50		79 20			49	7.50		79 49			20	8.57		80 16			2	10.4
89	27	20.0		84 37			57	20.0		84 52			27	20.0		85 6			1	5.2
90	30			90 0			79 0			90 0			30			90 0			0	0.0
t	a	60′/Δ		b	Δ/60′		a	60′/Δ		b	Δ/60′		a	60′/Δ		b	Δ/60′			α
	d = 10° 30′						d = 11° 0′						d = 11° 30′							

b / B	a = 12° 0′					a = 12° 30′					a = 13° 0′					c / C	a / β
	h \ d	60′/Δ		Z \ t	Δ/60′	h \ d	60′/Δ		Z \ t	Δ/60′	h \ d	60′/Δ		Z \ t	Δ/60′		
°	° ′			° ′		° ′			° ′		° ′			° ′		°	°
0	0 0	1.02		12 0	0.00	0 0	1.02		12 30	0.00	0 0	1.03		13 0	0.00	90	90.0
1	59	1.03		0	.00	59	1.03		30	.00	58	1.02		0	.00	89	89.8
2	1 57	1.02		0	.02	1 57	1.02		30	.02	1 57	1.03		0	.02	88	89.6
3	2 56	1.02		1	.02	2 56	1.03		31	.02	2 55	1.02		1	.02	87	89.4
4	3 55	1.03		2	.02	3 54	1.02		32	.02	3 54	1.03		2	.02	86	89.1
5	4 53	1.02		3	0.02	4 53	1.03		33	0.02	4 52	1.02		3	0.02	85	88.9
6	5 52	1.02		4	.02	5 51	1.02		34	.02	5 51	1.03		4	.03	84	88.7
7	6 51	1.03		5	.03	6 50	1.02		35	.03	6 49	1.02		6	.03	83	88.5
8	7 49	1.02		7	.03	7 49	1.03		37	.03	7 48	1.03		8	.03	82	88.3
9	8 48	1.02		9	.03	8 47	1.02		39	.03	8 46	1.03		10	.03	81	88.0
10	9 47	1.03		11	0.03	9 46	1.03		41	0.03	9 44	1.02		12	0.03	80	87.8
11	10 45	1.02		13	.05	10 44	1.02		43	.05	10 43	1.03		14	.05	79	87.6
12	11 44	1.02		16	.05	11 43	1.03		46	.05	11 41	1.02		17	.05	78	87.4
13	12 43	1.03		19	.05	12 41	1.02		49	.05	12 40	1.03		20	.05	77	87.1
14	13 41	1.02		22	.05	13 40	1.03		52	.07	13 38	1.03		23	.05	76	86.9
15	14 40	1.03		25	0.05	14 38	1.02		56	0.05	14 36	1.02		26	0.07	75	86.7
16	15 38	1.02		28	.07	15 37	1.03		59	.07	15 35	1.03		30	.07	74	86.4
17	16 37	1.02		32	.07	16 35	1.02	13	3	.07	16 33	1.03		34	.08	73	86.2
18	17 36	1.03		36	.07	17 34	1.03		7	.08	17 31	1.02		39	.07	72	86.0
19	18 34	1.02		40	.08	18 32	1.03		12	.08	18 30	1.03		43	.08	71	85.7
20	19 33	1.03		45	0.08	19 30	1.02		17	0.08	19 28	1.03		48	0.08	70	85.5
21	20 31	1.02		50	.08	20 29	1.03		22	.08	20 26	1.03		53	.10	69	85.3
22	21 30	1.03		55	.08	21 27	1.03		27	.10	21 24	1.02		59	.10	68	85.0
23	22 28	1.02	13	0	.10	22 25	1.02		33	.10	22 23	1.03	14	5	.10	67	84.8
24	23 27	1.03		6	.10	23 24	1.03		39	.10	23 21	1.03		11	.10	66	84.5
25	24 25	1.03		12	0.10	24 22	1.03		45	0.10	24 19	1.03		17	0.12	65	84.2
26	25 23	1.02		18	.12	25 20	1.02		51	.12	25 17	1.03		24	.12	64	84.0
27	26 22	1.03		25	.12	26 19	1.03		58	.13	26 15	1.03		31	.13	63	83.7
28	27 20	1.03		32	.13	27 17	1.03	14	6	.13	27 13	1.03		39	.13	62	83.4
29	28 18	1.02		40	.13	28 15	1.03		14	.13	28 11	1.03		47	.15	61	83.2
30	29 17	1.03		48	0.13	29 13	1.03		22	0.13	29 9	1.03		56	0.15	60	82.9
31	30 15	1.03		56	.13	30 11	1.03		30	.15	30 7	1.03	15	5	.15	59	82.6
32	31 13	1.03	14	4	.15	31 9	1.03		39	.15	31 5	1.03		14	.17	58	82.3
33	32 11	1.02		13	.17	32 7	1.03		48	.17	32 3	1.03		24	.17	57	82.0
34	33 10	1.03		23	.17	33 5	1.03		58	.18	33 1	1.03		34	.17	56	81.7
35	34 8	1.03		33	0.17	34 3	1.03	15	9	0.18	59	1.05		44	0.18	55	81.4
36	35 6	1.03		43	.18	35 1	1.03		20	.18	34 56	1.03		55	.20	54	81.1
37	36 4	1.03		54	.20	59	1.03		31	.20	35 54	1.03	16	7	.22	53	80.7
38	37 2	1.03	15	6	.20	36 57	1.03		43	.20	36 52	1.05		20	.22	52	80.4
39	38 0	1.05		18	.22	37 55	1.05		55	.22	37 49	1.03		33	.22	51	80.1
40	57	1.03		31	0.22	38 52	1.03	16	8	0.23	38 47	1.05		46	0.23	50	79.7
41	39 55	1.03		44	.23	39 50	1.05		22	.25	39 44	1.05	17	0	.25	49	79.3
42	40 53	1.03		58	.23	40 47	1.03		37	.25	40 41	1.03		15	.27	48	79.0
43	41 51	1.05	16	12	.27	41 45	1.05		52	.27	41 39	1.05		31	.28	47	78.6
44	42 48	1.03		28	.27	42 42	1.05	17	8	.28	42 36	1.05		48	.28	46	78.2
45	43 46			44		43 39			25		43 33		18	5		45	77.8
t	a	60′/Δ		b	Δ/60′	a	60′/Δ		b	Δ/60′	a	60′/Δ		b	Δ/60′		a
	d = 12° 0′					d = 12° 30′					d = 13° 0′						

b / B	a = 12° 0′					a = 12° 30′					a = 13° 0′					c / C	a / β
	h \ d	60′/Δ	Z \ t	Δ/60′		h \ d	60′/Δ	Z \ t	Δ/60′		h \ d	60′/Δ	Z \ t	Δ/60′			
°	° ′		° ′			° ′		° ′			° ′		° ′			°	°
45	43 46	1.05	16 44	0.28		43 39	1.03	17 25	0.28		43 33	1.05	18 5	0.30		45	77.8
46	44 43	1.05	17 1	.30		44 37	1.05	42	.30		44 30	1.05	23	.32		44	77.4
47	45 40	1.03	19	.30		45 34	1.05	18 0	.33		45 27	1.05	42	.33		43	76.9
48	46 38	1.05	37	.33		46 31	1.05	20	.33		46 24	1.07	19 2	.35		42	76.5
49	47 35	1.05	57	.35		47 28	1.07	40	.37		47 20	1.05	23	.37		41	76.0
50	48 32	1.05	18 18	0.37		48 24	1.05	19 2	0.37		48 17	1.07	45	0.40		40	75.5
51	49 29	1.05	40	.38		49 21	1.05	24	.40		49 13	1.07	20 9	.40		39	75.0
52	50 26	1.07	19 3	.40		50 18	1.07	48	.42		50 9	1.07	33	.43		38	74.5
53	51 22	1.05	27	.43		51 14	1.07	20 13	.45		51 5	1.07	59	.47		37	74.0
54	52 19	1.07	53	.45		52 10	1.07	40	.47		52 1	1.07	21 27	.48		36	73.4
55	53 15	1.07	20 20	0.48		53 6	1.07	21 8	0.50		57	1.07	56	0.50		35	72.8
56	54 11	1.07	49	.50		54 2	1.07	38	.52		53 53	1.09	22 26	.53		34	72.2
57	55 7	1.07	21 19	.53		58	1.09	22 9	.55		54 48	1.09	58	.58		33	71.6
58	56 3	1.07	51	.58		55 53	1.09	42	.58		55 43	1.09	23 33	.60		32	70.9
59	59	1.09	22 26	.60		56 48	1.09	23 17	.63		56 38	1.09	24 9	.63		31	70.2
60	57 54	1.09	23 2	0.65		57 43	1.09	55	0.67		57 33	1.11	47	0.68		30	69.5
61	58 49	1.09	41	.68		58 38	1.09	24 35	.70		58 27	1.11	25 28	.72		29	6 .7
62	59 44	1.11	24 22	.72		59 33	1.11	25 17	.75		59 21	1.11	26 11	.77		28	67.9
63	60 38	1.11	25 5	.78		60 27	1.11	26 2	.80		60 15	1.13	57	.82		27	67.0
64	61 32	1.11	52	.83		61 21	1.13	50	.85		61 8	1.13	27 46	.88		26	66.1
65	62 26	1.11	26 42	0.90		62 14	1.13	27 41	0.92		62 1	1.15	28 39	0.93		25	65.1
66	63 20	1.13	27 36	.95		63 7	1.15	28 36	.97		53	1.15	29 35	1.00		24	64.1
67	64 13	1.15	28 33	1.02		59	1.15	29 34	1.05		63 45	1.15	30 35	1.07		23	63.0
68	65 5	1.15	29 34	1.10		64 51	1.18	30 37	1.13		64 37	1.18	31 39	1.13		22	61.8
69	57	1.18	30 40	1.20		65 42	1.18	31 45	1.20		65 28	1.20	32 47	1.23		21	60.6
70	66 48	1.18	31 52	1.27		66 33	1.20	32 57	1.30		66 18	1.22	34 1	1.32		20	59.3
71	67 39	1.20	33 8	1.38		67 23	1.22	34 15	1.40		67 7	1.25	35 20	1.43		19	57.8
72	68 29	1.22	34 31	1.50		68 12	1.25	35 39	1.52		55	1.25	36 46	1.53		18	56.3
73	69 18	1.25	36 1	1.62		69 0	1.25	37 10	1.65		68 43	1.28	38 18	1.65		17	54.7
74	70 6	1.28	37 38	1.77		48	1.30	38 49	1.77		69 30	1.33	39 57	1.78		16	53.0
75	53	1.33	39 24	1.90		70 34	1.33	40 35	1.92		70 15	1.36	41 44	1.93		15	51.1
76	71 38	1.33	41 18	2.08		71 19	1.40	42 30	2.08		59	1.40	43 40	2.08		14	49.0
77	72 23	1.40	43 23	2.25		72 2	1.43	44 35	2.25		71 42	1.46	45 45	2.25		13	46.8
78	73 6	1.46	45 38	2.45		44	1.50	46 50	2.45		72 23	1.54	48 0	2.43		12	44.5
79	47	1.54	48 5	2.67		73 24	1.58	49 17	2.65		73 2	1.62	50 26	2.62		11	41.9
80	74 26	1.67	50 45	2.90		74 2	1.67	51 56	2.87		39	1.71	53 3	2.83		10	39.2
81	75 2	1.71	53 39	3.13		38	1.76	54 48	3.08		74 14	1.88	55 53	3.03		9	36.2
82	37	1.94	56 47	3.38		75 12	2.00	57 53	3.32		46	2.00	58 55	3.25		8	33.0
83	76 8	2.14	60 10	3.65		42	2.22	61 12	3.55		75 16	2.31	62 10	3.47		7	29.6
84	36	2.40	63 49	3.88		76 9	2.50	64 45	3.78		42	2.61	65 38	3.68		6	25.9
85	77 1	2.86	67 42	4.13		33	3.00	68 32	4.00		76 5	3.00	69 19	3.87		5	22.0
86	22	3.75	71 50	4.33		53	3.75	72 32	4.18		25	4.00	73 11	4.05		4	17.9
87	38	5.00	76 10	4.52		77 9	5.00	76 43	4.33		40	5.45	77 14	4.17		3	13.6
88	50	7.50	80 41	4.62		21	8.57	81 3	4.45		51	8.57	81 24	4.28		2	9.2
89	58	30.0	85 18			28	30.0	85 30	4.50		58	30.0	85 41	4.32		1	4.6
90	78 0		90 0			30		90 0			77 0		90 0			0	0.0
t	a	60′/Δ	b	Δ/60′		a	60′/Δ	b	Δ/60′		a	60′/Δ	b	Δ/60′			a
	d = 12° 0′					d = 12° 30′					d = 13° 0′						

b / B	a = 13° 30′ h	d	60′/Δ	Z	t	Δ/60′	a = 14° 0′ h	d	60′/Δ	Z	t	Δ/60′	a = 14° 30′ h	d	60′/Δ	Z	t	Δ/60′	c / C	a / β
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
0	0 0		1.03	13 30		0.00	0 0		1.03	14 0		0.00	0 0		1.03	14 30		0.00	90	90.0
1	58		1.02	30		.00	58		1.03	0		.00	58		1.03	30		.02	89	89.8
2	1 57		1.03	30		.02	1 56		1.02	0		.02	1 56		1.03	31		.00	88	89.5
3	2 55		1.03	31		.02	2 55		1.03	1		.02	2 54		1.03	31		.02	87	89.3
4	3 53		1.02	32		.02	3 53		1.03	2		.02	3 52		1.03	32		.02	86	89.0
5	4 52		1.03	33		0.02	4 51		1.03	3		0.02	4 50		1.03	33		0.03	85	88.8
6	5 50		1.03	34		.03	5 49		1.03	4		.03	5 48		1.02	35		.02	84	88.5
7	6 48		1.02	36		.03	6 47		1.02	6		.03	6 47		1.03	36		.03	83	88.3
8	7 47		1.03	38		.03	7 46		1.03	8		.03	7 45		1.03	38		.03	82	88.1
9	8 45		1.03	40		.03	8 44		1.03	10		.03	8 43		1.03	40		.05	81	87.8
10	9 43		1.02	42		0.05	9 42		1.03	12		0.05	9 41		1.03	43		0.05	80	87.6
11	10 42		1.03	45		.05	10 40		1.03	15		.05	10 39		1.03	46		.05	79	87.3
12	11 40		1.03	48		.05	11 38		1.03	18		.05	11 37		1.03	49		.05	78	87.1
13	12 38		1.03	51		.05	12 36		1.02	21		.07	12 35		1.03	52		.05	77	86.8
14	13 36		1.02	54		.07	13 35		1.03	25		.05	13 33		1.03	55		.07	76	86.5
15	14 35		1.03	58		0.07	14 33		1.03	28		0.07	14 31		1.03	59		0.07	75	86.3
16	15 33		1.03	14 2		.07	15 31		1.03	32		.08	15 29		1.03	15 3		.08	74	86.0
17	16 31		1.03	6		.07	16 29		1.03	37		.07	16 27		1.05	8		.08	73	85.8
18	17 29		1.03	10		.08	17 27		1.03	41		.08	17 24		1.03	13		.08	72	85.5
19	18 27		1.03	15		.08	18 25		1.03	46		.10	18 22		1.03	18		.08	71	85.2
20	19 25		1.02	20		0.08	19 23		1.03	52		0.08	19 20		1.03	23		0.10	70	85.0
21	20 24		1.03	25		.10	20 21		1.03	57		.10	20 18		1.03	29		.10	69	84.7
22	21 22		1.03	31		.10	21 19		1.03	15 3		.10	21 16		1.03	35		.12	68	84.4
23	22 20		1.03	37		.10	22 17		1.03	9		.12	22 14		1.05	42		.10	67	84.1
24	23 18		1.03	43		.12	23 15		1.03	16		.12	23 11		1.03	48		.12	66	83.9
25	24 16		1.03	50		0.12	24 13		1.05	23		0.12	24 9		1.03	55		0.13	65	83.6
26	25 14		1.03	57		.13	25 10		1.03	30		.13	25 7		1.05	16 3		.13	64	83.3
27	26 12		1.03	15 5		.13	26 8		1.03	38		.13	26 4		1.03	11		.13	63	83.0
28	27 10		1.03	13		.13	27 6		1.03	46		.15	27 2		1.03	19		.15	62	82.7
29	28 8		1.05	21		.15	28 4		1.05	55		.15	28 0		1.05	28		.15	61	82.4
30	29 5		1.03	30		0.15	29 1		1.03	16 4		0.15	57		1.03	37		0.17	60	82.0
31	30 3		1.03	39		.15	59		1.03	13		.17	29 55		1.05	47		.17	59	81.7
32	31 1		1.03	48		.17	30 57		1.05	23		.17	30 52		1.05	57		.18	58	81.4
33	59		1.05	58		.18	31 54		1.03	33		.18	31 49		1.03	17 8		.18	57	81.1
34	32 56		1.03	16 9		.18	32 52		1.05	44		.20	32 47		1.05	19		.20	56	80.7
35	33 54		1.05	20		0.20	33 49		1.05	56		0.20	33 44		1.05	31		0.22	55	80.4
36	34 51		1.03	32		.20	34 46		1.03	17 8		.20	34 41		1.05	44		.22	54	80.0
37	35 49		1.05	44		.22	35 44		1.05	20		.22	35 38		1.05	57		.22	53	79.7
38	36 46		1.03	57		.22	36 41		1.05	33		.23	36 35		1.05	18 10		.23	52	79.3
39	37 44		1.05	17 10		.23	37 38		1.05	47		.25	37 32		1.05	24		.25	51	78.9
40	38 41		1.05	24		0.25	38 35		1.05	18 2		0.25	38 29		1.05	39		0.27	50	78.5
41	39 38		1.05	39		.25	39 32		1.05	17		.27	39 26		1.05	55		.27	49	78.1
42	40 35		1.05	54		.27	40 29		1.05	33		.28	40 23		1.07	19 11		.28	48	77.7
43	41 32		1.05	18 10		.28	41 26		1.05	50		.28	41 19		1.05	28		.30	47	77.3
44	42 29		1.05	27		.30	42 23		1.07	19 7		.30	42 16		1.07	46		.32	46	76.9
45	43 26			45			43 19			25			43 12			20 5			45	76.4
t	a	60′/Δ		b		Δ/60′	a	60′/Δ		b		Δ/60′	a	60′/Δ		b		Δ/60′		a
	d = 13° 30′						d = 14° 0′						d = 14° 30′							

b / B	a = 13° 30′ h	d	60′/Δ	Z	t	Δ/60′	a = 14° 0′ h	d	60′/Δ	Z	t	Δ/60′	a = 14° 30′ h	d	60′/Δ	Z	t	Δ/60′	c / C	a / β
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
45	43 26		1.05	18 45		0.32	43 19		1.05	19 25		0.33	43 12		1.07	20 5		0.33	45	76.4
46	44 23		1.05	19 4		.33	44 16		1.07	45		.33	44 8		1.07	25		.35	44	75.9
47	45 20		1.07	24		.33	45 12		1.07	20 5		.35	45 4		1.07	46		.37	43	75.5
48	46 16		1.05	44		.37	46 8		1.07	26		.37	46 0		1.07	21 8		.38	42	75.0
49	47 13		1.07	20 6		.38	47 4		1.07	48		.40		56	1.07	31		.40	41	74.4
50	48 9		1.07	29		0.40	48 0		1.07	21 12		0.42	47 52		1.07	55		0.42	40	73.9
51	49 5		1.07	53		.42		56	1.07	37		.43	48 48		1.09	22 20		.45	39	73.4
52	50 1		1.07	21 18		.45	49 52		1.07	22 3		.45	49 43		1.09	47		.47	38	72.8
53		57	1.07	45		.47	50 48		1.09	30		.48	50 38		1.09	23 15		.50	37	72.2
54	51 53		1.09	22 13		.50	51 43		1.09	59		.52	51 33		1.09	45		.52	36	71.6
55	52 48		1.09	43		0.52	52 38		1.09	23 30		0.53	52 28		1.09	24 16		0.55	35	70.9
56	53 43		1.09	23 14		.55	53 33		1.09	24 2		.57	53 23		1.11	49		.58	34	70.3
57	54 38		1.09	47		.58	54 28		1.11	36		.60	54 17		1.11	25 24		.62	33	69.6
58	55 33		1.09	24 22		.63	55 22		1.11	25 12		.63	55 11		1.11	26 1		.65	32	68.8
59	56 28		1.11	25 0		.65	56 16		1.11	50		.67	56 5		1.11	40		.68	31	68.1
60	57 22		1.11	39		0.70	57 10		1.11	26 30		0.72		59	1.13	27 21		0.73	30	67.3
61	58 16		1.13	26 21		.73	58 4		1.13	27 13		.77	57 52		1.13	28 5		.77	29	66.4
62	59 9		1.13	27 5		.78		57	1.13	59		.80	58 45		1.15	51		.82	28	65.5
63	60 2		1.13	52		.83	59 50		1.15	28 47		.85	59 37		1.15	29 40		.87	27	64.6
64		55	1.13	28 42		.90	60 42		1.15	29 38		.90	60 29		1.18	30 32		.93	26	63.6
65	61 48		1.15	29 36		0.95	61 34		1.18	30 32		0.98	61 20		1.18	31 28		0.98	25	62.6
66	62 40		1.18	30 33		1.02	62 25		1.18	31 31		1.03	62 11		1.20	32 27		1.05	24	61.5
67	63 31		1.18	31 34		1.08	63 16		1.18	32 33		1.10	63 1		1.20	33 30		1.12	23	60.3
68	64 22		1.20	32 39		1.17	64 7		1.22	33 39		1.18		51	1.22	34 37		1.20	22	59.1
69	65 12		1.20	33 49		1.25		56	1.22	34 50		1.25	64 40		1.25	35 49		1.28	21	57.8
70	66 2		1.25	35 4		1.33	65 45		1.25	36 5		1.37	65 28		1.25	37 6		1.37	20	56.4
71		50	1.25	36 24		1.45	66 33		1.28	37 27		1.45	66 16		1.30	38 28		1.47	19	54.9
72	67 38		1.28	37 51		1.55	67 20		1.28	38 54		1.55	67 2		1.30	39 56		1.57	18	53.3
73	68 25		1.30	39 24		1.65	68 7		1.33	40 27		1.68		48	1.36	41 30		1.68	17	51.6
74	69 11		1.36	41 3		1.80		52	1.36	42 8		1.80	68 32		1.40	43 11		1.80	16	49.8
75		55	1.36	42 51		1.93	69 36		1.43	43 56		1.93	69 15		1.43	44 59		1.93	15	47.9
76	70 39		1.43	44 47		2.08	70 18		1.46	45 52		2.08		57	1.50	46 55		2.07	14	45.9
77	71 21		1.50	46 52		2.23		59	1.54	47 57		2.23	70 37		1.54	48 59		2.22	13	43.7
78	72 1		1.58	49 6		2.42	71 38		1.58	50 11		2.40	71 16		1.67	51 12		2.38	12	41.3
79		39	1.67	51 31		2.60	72 16		1.71	52 35		2.57		52	1.71	53 35		2.53	11	38.8
80	73 15		1.76	54 7		2.80		51	1.82	55 9		2.75	72 27		1.88	56 7		2.72	10	36.1
81		49	1.88	56 55		2.98	73 24		1.94	57 54		2.93		59	2.00	58 50		2.88	9	33.2
82	74 21		2.14	59 54		3.18		55	2.14	60 50		3.12	73 29		2.22	61 43		3.05	8	30.2
83		49	2.31	63 5		3.38	74 23		2.40	63 57		3.30		56	2.50	64 46		3.22	7	26.9
84	75 15		2.73	66 28		3.58		48	2.86	67 15		3.48	74 20		2.86	67 59		3.38	6	23.5
85		37	3.16	70 3		3.75	75 9		3.33	70 44		3.63		41	3.53	71 22		3.53	5	19.9
86		56	4.00	73 48		3.90		27	4.29	74 22		3.78		58	4.29	74 54		3.67	4	16.1
87	76 11		6.00	77 42		4.03		41	5.45	78 9		3.88	75 12		6.00	78 34		3.75	3	12.2
88		21	8.57	81 44		4.12		52	10.0	82 2		3.97		22	10.0	82 19		3.82	2	8.2
89		28	30.0	85 51		4.15		58	30.0	86 0		4.00		28	30.0	86 8		3.87	1	4.1
90		30		90 0			76 0			90 0				30		90 0			0	0.0

t	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a
	d = 13° 30′				d = 14° 0′				d = 14° 30′				

b / B	a = 15° 0′						a = 15° 30′						a = 16° 0′						c / C	a / β
	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′		
°	°	′		°	′		°	′		°	′		°	′		°	′			°
0	0	0	1.03	15	0	0.00	0	0	1.03	15	30	0.00	0	0	1.03	16	0	0.00	90	90.0
1		58	1.03		0	.02		58	1.03		30	.02		58	1.05		0	.02	89	89.7
2	1	56	1.03		1	.00	1	56	1.05		31	.00	1	55	1.03		1	.00	88	89.5
3	2	54	1.03		1	.02	2	53	1.03		31	.02	2	53	1.03		1	.02	87	89.2
4	3	52	1.03		2	.02	3	51	1.03		32	.02	3	51	1.05		2	.02	86	88.9
5	4	50	1.03		3	0.03	4	49	1.03		33	0.03	4	48	1.03		3	0.03	85	88.7
6	5	48	1.03		5	.03	5	47	1.03		35	.03	5	46	1.03		5	.03	84	88.4
7	6	46	1.03		7	.03	6	45	1.05		37	.03	6	44	1.05		7	.03	83	88.1
8	7	44	1.05		9	.03	7	42	1.03		39	.03	7	41	1.03		9	.03	82	87.8
9	8	41	1.03		11	.03	8	40	1.03		41	.05	8	39	1.03		11	.05	81	87.6
10	9	39	1.03		13	0.05	9	38	1.03		44	0.05	9	37	1.05		14	0.05	80	87.3
11	10	37	1.03		16	.05	10	36	1.05		47	.05	10	34	1.03		17	.05	79	87.0
12	11	35	1.03		19	.05	11	33	1.03		50	.05	11	32	1.05		20	.07	78	86.7
13	12	33	1.03		22	.07	12	31	1.03		53	.07	12	29	1.03		24	.07	77	86.5
14	13	31	1.03		26	.07	13	29	1.03		57	.07	13	27	1.05		28	.07	76	86.2
15	14	29	1.05		30	0.08	14	27	1.05	16	1	0.07	14	24	1.03		32	0.08	75	85.9
16	15	26	1.03		35	.07	15	24	1.03		5	.08	15	22	1.05		37	.08	74	85.6
17	16	24	1.03		39	.08	16	22	1.03		10	.08	16	19	1.03		42	.08	73	85.3
18	17	22	1.03		44	.08	17	20	1.05		15	.10	17	17	1.05		47	.08	72	85.0
19	18	20	1.05		49	.10	18	17	1.03		21	.10	18	14	1.03		52	.10	71	84.7
20	19	17	1.03		55	0.10	19	15	1.05		27	0.10	19	12	1.05		58	0.10	70	84.4
21	20	15	1.03	16	1	.10	20	12	1.03		33	.10	20	9	1.05	17	4	.12	69	84.1
22	21	13	1.05		7	.12	21	10	1.05		39	.12	21	6	1.03		11	.12	68	83.8
23	22	10	1.03		14	.12	22	7	1.03		46	.12	22	4	1.05		18	.13	67	83.5
24	23	8	1.03		21	.12	23	5	1.05		53	.13	23	1	1.05		26	.13	66	83.2
25	24	6	1.05		28	0.13	24	2	1.05	17	1	0.13		58	1.05		34	0.13	65	82.9
26	25	3	1.03		36	.13		59	1.03		9	.13	24	55	1.05		42	.13	64	82.6
27	26	1	1.05		44	.15	25	57	1.05		17	.15	25	52	1.03		50	.15	63	82.2
28		58	1.05		53	.15	26	54	1.05		26	.15	26	50	1.05		59	.17	62	81.9
29	27	55	1.03	17	2	.17	27	51	1.05		35	.17	27	47	1.05	18	9	.17	61	81.6
30	28	53	1.05		12	0.17	28	48	1.05		45	0.18	28	44	1.05		19	0.18	60	81.2
31	29	50	1.05		22	.17	29	45	1.05		56	.18	29	41	1.07		30	.18	59	80.9
32	30	47	1.05		32	.18	30	42	1.05	18	7	.18	30	37	1.05		41	.20	58	80.5
33	31	44	1.03		43	.20	31	39	1.05		18	.20	31	34	1.05		53	.20	57	80.2
34	32	42	1.05		55	.20	32	36	1.05		30	.20	32	31	1.05	19	5	.22	56	79.8
35	33	39	1.05	18	7	0.22	33	33	1.05		42	0.22	33	28	1.07		18	0.22	55	79.4
36	34	36	1.05		20	.22	34	30	1.05		55	.23	34	24	1.05		31	.23	54	79.0
37	35	33	1.07		33	.23	35	27	1.07	19	9	.23	35	21	1.07		45	.25	53	78.6
38	36	29	1.05		47	.23	36	23	1.05		23	.25	36	17	1.07	20	0	.25	52	78.2
39	37	26	1.05	19	1	.27	37	20	1.07		38	.27	37	13	1.05		15	.27	51	77.8
40	38	23	1.07		17	0.27	38	16	1.05		54	0.28	38	10	1.07		31	0.28	50	77.4
41	39	19	1.05		33	.28	39	13	1.07	20	11	.28	39	6	1.07		48	.30	49	76.9
42	40	16	1.07		50	.28	40	9	1.07		28	.30	40	2	1.07	21	6	.32	48	76.5
43	41	12	1.05	20	7	.32	41	5	1.07		46	.32		58	1.07		25	.32	47	76.0
44	42	9	1.07		26	.32	42	1	1.07	21	5	.33	41	54	1.09		44	.33	46	75.5
45	43	5			45			57			25		42	49		22	4		45	75.0
t	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′		a
	d = 15° 0′						d = 15° 30′						d = 16° 0′							

b / B	$a = 15° 0'$ h / d	60′/Δ	Z / t	Δ/60′	$a = 15° 30'$ h / d	60′/Δ	Z / t	Δ/60′	$a = 16° 0'$ h / d	60′/Δ	Z / t	Δ/60′	c / C	a / β
°	° ′		° ′		° ′		° ′		° ′		° ′		°	°
45	43 5	1.07	20 45	0.35	42 57	1.07	21 25	0.35	42 49	1.07	22 4	0.37	45	75.0
46	44 1	1.07	21 6	.35	43 53	1.07	46	.37	43 45	1.09	26	.37	44	74.5
47	57	1.07	27	.38	44 49	1.09	22 8	.38	44 40	1.09	48	.40	43	74.0
48	45 53	1.09	49	.40	45 44	1.09	31	.40	45 35	1.09	23 12	.42	42	73.5
49	46 48	1.07	22 13	.42	46 39	1.09	55	.42	46 30	1.09	37	.43	41	72.9
50	47 44	1.09	38	0.43	47 34	1.09	23 20	0.45	47 25	1.09	24 3	0.45	40	72.3
51	48 39	1.09	23 4	.45	48 29	1.09	47	.47	48 20	1.09	30	.48	39	71.7
52	49 34	1.09	31	.48	49 24	1.09	24 15	.48	49 15	1.11	59	.50	38	71.1
53	50 29	1.09	24 0	.50	50 19	1.11	44	.52	50 9	1.11	25 29	.52	37	70.5
54	51 24	1.11	30	.53	51 13	1.11	25 15	.55	51 3	1.11	26 0	.57	36	69.8
55	52 18	1.11	25 2	0.57	52 7	1.11	48	0.58	57	1.13	34	0.58	35	69.1
56	53 12	1.11	36	.60	53 1	1.11	26 23	.60	52 50	1.13	27 9	.62	34	68.4
57	54 6	1.11	26 12	.62	55	1.13	59	.63	53 43	1.13	46	.65	33	67.6
58	55 0	1.13	49	.67	54 48	1.13	27 37	.68	54 36	1.13	28 25	.68	32	66.8
59	53	1.13	27 29	.70	55 41	1.13	28 18	.72	55 29	1.15	29 6	.73	31	66.0
60	56 46	1.13	28 11	0.75	56 34	1.15	29 1	0.75	56 21	1.15	50	0.77	30	65.2
61	57 39	1.15	56	.78	57 26	1.15	46	.80	57 13	1.18	30 36	.82	29	64.3
62	58 31	1.15	29 43	.83	58 18	1.15	30 34	.85	58 4	1.18	31 25	.87	28	63.3
63	59 23	1.15	30 33	.88	59 10	1.18	31 25	.90	55	1.18	32 17	.90	27	62.3
64	60 15	1.18	31 26	.95	60 1	1.20	32 19	.95	59 46	1.20	33 11	.97	26	61.3
65	61 6	1.20	32 23	1.00	51	1.20	33 16	1.02	60 36	1.22	34 9	1.03	25	60.2
66	56	1.20	33 23	1.07	61 41	1.22	34 17	1.08	61 25	1.22	35 11	1.10	24	59.0
67	62 46	1.22	34 27	1.13	62 30	1.22	35 22	1.15	62 14	1.25	36 17	1.15	23	57.8
68	63 35	1.25	35 35	1.20	63 19	1.25	36 31	1.22	63 2	1.28	37 26	1.23	22	56.5
69	64 23	1.25	36 47	1.28	64 7	1.28	37 44	1.30	49	1.28	38 40	1.30	21	55.2
70	65 11	1.28	38 4	1.38	54	1.30	39 2	1.38	64 36	1.33	39 58	1.40	20	53.7
71	58	1.30	39 27	1.48	65 40	1.33	40 25	1.48	65 21	1.33	41 22	1.50	19	52.2
72	66 44	1.33	40 56	1.57	66 25	1.36	41 54	1.58	66 6	1.40	42 52	1.58	18	50.6
73	67 29	1.40	42 30	1.68	67 9	1.40	43 29	1.70	49	1.43	44 27	1.68	17	48.8
74	68 12	1.40	44 11	1.80	52	1.43	45 11	1.80	67 31	1.46	46 8	1.80	16	47.0
75	55	1.46	45 59	1.93	68 34	1.50	46 59	1.92	68 12	1.50	47 56	1.92	15	45.1
76	69 36	1.54	47 55	2.07	69 14	1.58	48 54	2.05	52	1.58	49 51	2.03	14	43.0
77	70 15	1.58	49 59	2.22	52	1.62	50 57	2.18	69 30	1.67	51 53	2.17	13	40.8
78	53	1.71	52 12	2.35	70 29	1.71	53 8	2.33	70 6	1.76	54 3	2.30	12	38.5
79	71 28	1.76	54 33	2.50	71 4	1.82	55 28	2.48	40	1.88	56 21	2.45	11	36.0
80	72 2	1.88	57 3	2.67	37	1.94	57 57	2.62	71 12	2.00	58 48	2.58	10	33.4
81	34	2.07	59 43	2.83	72 8	2.14	60 34	2.78	42	2.22	61 23	2.73	9	30.7
82	73 3	2.31	62 33	2.98	36	2.31	63 21	2.93	72 9	2.40	64 7	2.87	8	27.7
83	29	2.61	65 32	3.15	73 2	2.73	66 17	3.07	34	2.73	66 59	3.00	7	24.7
84	52	3.00	68 41	3.30	24	3.00	69 21	3.20	56	3.16	69 59	3.12	6	21.5
85	74 12	3.53	71 59	3.43	44	3.75	72 33	3.33	73 15	3.75	73 6	3.23	5	18.1
86	29	4.29	75 25	3.53	74 0	4.62	75 53	3.43	31	4.62	76 20	3.32	4	14.7
87	43	6.67	78 57	3.63	13	6.67	79 19	3.52	44	6.67	79 39	3.42	3	11.1
88	52	10.0	82 35	3.68	22	10.0	82 50	3.57	53	12.0	83 4	3.45	2	7.4
89	58	30.0	86 16	3.73	28	30.0	86 24	3.60	58	30.0	86 31	3.48	1	3.7
90	75 0		90 0		30		90 0		74 0		90 0		0	0.0
t	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′		a
	$d = 15° 0'$				$d = 15° 30'$				$d = 16° 0'$					

b / B	a = 16° 30′						a = 17° 0′						a = 17° 30′						c / C	a / β
	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′		
°	°	′		°	′		°	′		°	′		°	′		°	′		°	°
0	0	0	1.03	16	30	0.00	0	0	1.05	17	0	0.00	0	0	1.05	17	30	0.00	90	90.0
1		58	1.05		30	.02		57	1.03		0	.02		57	1.05		30	.02	89	89.7
2	1	55	1.03		31	.00	1	55	1.05		1	.00	1	54	1.03		31	.00	88	89.4
3	2	53	1.05		31	.02	2	52	1.05		1	.02	2	52	1.05		31	.02	87	89.1
4	3	50	1.03		32	.03	3	49	1.03		2	.03	3	49	1.05		32	.03	86	88.8
5	4	48	1.05		34	0.02	4	47	1.05		4	0.02	4	46	1.05		34	0.02	85	88.5
6	5	45	1.03		35	.03	5	44	1.03		5	.03	5	43	1.05		35	.03	84	88.2
7	6	43	1.05		37	.03	6	42	1.05		7	.03	6	40	1.03		37	.05	83	87.9
8	7	40	1.03		39	.05	7	39	1.05		9	.05	7	38	1.05		40	.03	82	87.6
9	8	38	1.05		42	.05	8	36	1.03		12	.05	8	35	1.05		42	.05	81	87.3
10	9	35	1.03		45	0.05	9	34	1.05		15	0.05	9	32	1.05		45	0.05	80	87.0
11	10	33	1.05		48	.05	10	31	1.05		18	.05	10	29	1.05		48	.07	79	86.7
12	11	30	1.05		51	.07	11	28	1.05		21	.07	11	26	1.05		52	.07	78	86.4
13	12	27	1.03		55	.07	12	25	1.03		25	.07	12	23	1.05		56	.07	77	86.1
14	13	25	1.05		59	.07	13	23	1.05		29	.08	13	20	1.05	18	0	.08	76	85.8
15	14	22	1.05	17	3	0.08	14	20	1.05		34	0.08	14	17	1.05		5	0.08	75	85.5
16	15	19	1.03		8	.08	15	17	1.05		39	.08	15	14	1.05		10	.08	74	85.2
17	16	17	1.05		13	.08	16	14	1.05		44	.08	16	11	1.05		15	.10	73	84.9
18	17	14	1.05		18	.10	17	11	1.05		49	.10	17	8	1.05		21	.10	72	84.6
19	18	11	1.03		24	.10	18	8	1.05		55	.10	18	5	1.05		27	.10	71	84.3
20	19	9	1.05		30	0.10	19	5	1.05	18	1	0.12	19	2	1.05		33	0.12	70	83.9
21	20	6	1.05		36	.12	20	2	1.05		8	.12		59	1.05		40	.12	69	83.6
22	21	3	1.05		43	.12		59	1.05		15	.12	20	56	1.05		47	.12	68	83.3
23	22	0	1.05		50	.13	21	56	1.05		22	.13	21	53	1.07		54	.13	67	82.9
24		57	1.05		58	.13	22	53	1.05		30	.13	22	49	1.05	19	2	.15	66	82.6
25	23	54	1.05	18	6	0.13	23	50	1.05		38	0.15	23	46	1.05		11	0.15	65	82.2
26	24	51	1.05		14	.15	24	47	1.05		47	.15	24	43	1.07		20	.15	64	81.9
27	25	48	1.05		23	.17	25	44	1.05		56	.17	25	39	1.05		29	.17	63	81.5
28	26	45	1.05		33	.17	26	41	1.07	19	6	.17	26	36	1.07		39	.17	62	81.2
29	27	42	1.05		43	.17	27	37	1.05		16	.18	27	32	1.05		49	.18	61	80.8
30	28	39	1.05		53	0.18	28	34	1.07		27	0.18	28	29	1.07	20	0	0.20	60	80.4
31	29	36	1.07	19	4	.18	29	30	1.05		38	.20	29	25	1.07		12	.20	59	80.0
32	30	32	1.05		15	.20	30	27	1.07		50	.20	30	21	1.05		24	.20	58	79.6
33	31	29	1.07		27	.22	31	23	1.05	20	2	.22	31	18	1.07		36	.22	57	79.2
34	32	25	1.05		40	.22	32	20	1.07		15	.22	32	14	1.07		49	.23	56	78.8
35	33	22	1.07		53	0.23	33	16	1.07		28	0.23	33	10	1.07	21	3	0.25	55	78.4
36	34	18	1.05	20	7	.23	34	12	1.07		42	.25	34	6	1.07		18	.25	54	78.0
37	35	15	1.07		21	.25	35	8	1.07		57	.25	35	2	1.07		33	.27	53	77.6
38	36	11	1.07		36	.27	36	4	1.07	21	12	.27		58	1.09		49	.27	52	77.1
39	37	7	1.07		52	.28	37	0	1.07		28	.28	36	53	1.07	22	5	.28	51	76.7
40	38	3	1.07	21	9	0.28		56	1.07		45	0.30	37	49	1.09		22	0.30	50	76.2
41		59	1.07		26	.30	38	52	1.09	22	3	.32	38	44	1.09		40	.32	49	75.7
42	39	55	1.09		44	.32	39	47	1.09		22	.32	39	39	1.09		59	.33	48	75.2
43	40	50	1.07	22	3	.33	40	42	1.07		41	.35	40	34	1.09	23	19	.35	47	74.7
44	41	46	1.09		23	.35	41	38	1.09	23	2	.35	41	29	1.09		40	.37	46	74.2
45	42	41			44		42	33			23		42	24		24	2		45	73.7
t	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′		a
	d = 16° 30′						d = 17° 0′						d = 17° 30′							

3·376 3·271 3·172

b / B	$a = 16° 30'$ d / h	60′/Δ	t / Z	Δ/60′	$a = 17° 0'$ d / h	60′/Δ	t / Z	Δ/60′	$a = 17° 30'$ d / h	60′/Δ	t / Z	Δ/60′	c / C	a / β
°	° ′		° ′		° ′		° ′		° ′		° ′		°	°
45	42 41	1.09	22 44	0.37	42 33	1.09	23 23	0.37	42 24	1.09	24 2	0.38	45	73.7
46	43 36	1.09	23 6	.38	43 28	1.09	45	.40	43 19	1.09	25	.40	44	73.2
47	44 31	1.09	29	.40	44 23	1.09	24 9	.40	44 14	1.11	49	.42	43	72.6
48	45 26	1.09	53	.42	45 18	1.11	33	.43	45 8	1.11	25 14	.43	42	72.0
49	46 21	1.09	24 18	.43	46 12	1.11	59	.45	46 2	1.11	40	.47	41	71.4
50	47 16	1.11	44	0.47	47 6	1.11	25 26	0.48	56	1.11	26 8	0.48	40	70.8
51	48 10	1.11	25 12	.50	48 0	1.11	55	.50	47 50	1.11	37	.50	39	70.1
52	49 4	1.11	42	.50	54	1.11	26 25	.52	48 44	1.13	27 7	.53	38	69.5
53	58	1.11	26 12	.55	49 48	1.13	56	.55	49 37	1.13	39	.57	37	68.8
54	50 52	1.11	45	.57	50 41	1.13	27 29	.58	50 30	1.13	28 13	.58	36	68.1
55	51 46	1.13	27 19	0.60	51 34	1.13	28 4	0.60	51 23	1.15	48	0.62	35	67.3
56	52 39	1.13	55	.62	52 27	1.13	40	.63	52 15	1.15	29 25	.65	34	66.6
57	53 32	1.15	28 32	.67	53 20	1.15	29 18	.68	53 7	1.15	30 4	.68	33	65.8
58	54 24	1.15	29 12	.70	54 12	1.15	59	.72	59	1.18	45	.72	32	64.9
59	55 16	1.15	54	.75	55 4	1.18	30 42	.75	54 50	1.18	31 28	.77	31	64.1
60	56 8	1.15	30 39	0.78	55	1.18	31 27	0.78	55 41	1.18	32 14	0.80	30	63.1
61	57 0	1.18	31 26	.82	56 46	1.20	32 14	.83	56 32	1.20	33 2	.85	29	62.2
62	51	1.20	32 15	.87	57 36	1.20	33 4	.88	57 22	1.22	53	.90	28	61.2
63	58 41	1.20	33 7	.93	58 26	1.20	57	.93	58 11	1.22	34 47	.95	27	60.2
64	59 31	1.22	34 3	.98	59 16	1.22	34 53	1.00	59 0	1.25	35 44	1.00	26	59.1
65	60 20	1.22	35 2	1.03	60 5	1.25	35 53	1.05	48	1.25	36 44	1.05	25	57.9
66	61 9	1.25	36 4	1.10	53	1.25	36 56	1.12	60 36	1.28	37 47	1.12	24	56.7
67	57	1.25	37 10	1.17	61 41	1.28	38 3	1.17	61 23	1.28	38 54	1.18	23	55.4
68	62 45	1.28	38 20	1.25	62 28	1.30	39 13	1.25	62 10	1.33	40 5	1.25	22	54.1
69	63 32	1.33	39 35	1.32	63 14	1.33	40 28	1.33	55	1.33	41 20	1.33	21	52.7
70	64 17	1.33	40 54	1.40	59	1.36	41 48	1.40	63 40	1.40	42 40	1.42	20	51.2
71	65 2	1.36	42 18	1.48	64 43	1.40	43 12	1.50	64 23	1.40	44 5	1.50	19	49.7
72	46	1.40	43 47	1.58	65 26	1.43	44 42	1.58	65 6	1.46	45 35	1.58	18	48.0
73	66 29	1.46	45 22	1.68	66 8	1.46	46 17	1.68	47	1.50	47 10	1.67	17	46.3
74	67 10	1.50	47 3	1.80	49	1.50	47 58	1.78	66 27	1.54	48 50	1.78	16	44.4
75	50	1.54	48 51	1.92	67 29	1.58	49 45	1.90	67 6	1.62	50 37	1.88	15	42.5
76	68 29	1.62	50 46	2.02	68 7	1.67	51 39	2.00	43	1.67	52 30	2.00	14	40.5
77	69 6	1.67	52 47	2.15	43	1.71	53 39	2.13	68 19	1.76	54 30	2.10	13	38.3
78	42	1.82	54 56	2.28	69 18	1.88	55 47	2.25	53	1.88	56 36	2.22	12	36.0
79	70 15	1.88	57 13	2.40	50	1.94	58 2	2.37	69 25	2.00	58 49	2.35	11	33.6
80	47	2.07	59 37	2.55	70 21	2.07	60 24	2.50	55	2.14	61 10	2.45	10	31.1
81	71 16	2.22	62 10	2.67	50	2.31	62 54	2.62	70 23	2.31	63 37	2.57	9	28.4
82	43	2.50	64 50	2.80	71 16	2.61	65 31	2.75	49	2.61	66 11	2.68	8	25.7
83	72 7	2.86	67 38	2.93	39	2.86	68 16	2.85	71 12	3.00	68 52	2.80	7	22.8
84	28	3.16	70 34	3.03	72 0	3.33	71 7	2.97	32	3.53	71 40	2.88	6	19.8
85	47	4.00	73 36	3.15	18	4.00	74 5	3.07	49	4.00	74 33	2.98	5	16.7
86	73 2	5.00	76 45	3.23	33	5.00	77 9	3.13	72 4	5.45	77 32	3.05	4	13.5
87	14	6.67	79 59	3.30	45	7.50	80 17	3.20	15	7.50	80 35	3.10	3	10.2
88	23	12.0	83 17	3.35	53	12.0	83 29	3.25	23	12.0	83 41	3.15	2	6.8
89	28	30.0	86 38	3.37	58	30.0	86 44	3.27	28	30.0	86 50	3.17	1	3.4
90	30		90 0		73 0		90 0		30		90 0		0	0.0
t	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′		a
	$d = 16° 30'$				$d = 17° 0'$				$d = 17° 30'$					

b / B	a = 18° 0′					a = 18° 30′					a = 19° 0′					c / C	a / β
	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′		
°	°	′		°	′		°	′		°	′		°	′		°	′			
0	0	0	1.05	18	0	0.00	0	0	1.05	18	30	0.00	0	0	1.05	19	0	0.00	**90**	90.0
1		57	1.05		0	.02		57	1.05		30	.02		57	1.05		0	.02	89	89.7
2	1	54	1.05		1	.00	1	54	1.05		31	.02	1	54	1.07		1	.02	88	89.4
3	2	51	1.05		1	.02	2	51	1.05		32	.02	2	50	1.05		2	.02	87	89.0
4	3	48	1.05		2	.03	3	48	1.05		33	.02	3	47	1.05		3	.02	86	88.7
5	4	45	1.05		4	0.03	4	45	1.07		34	0.03	4	44	1.07		4	0.03	85	88.4
6	5	42	1.05		6	.03	5	41	1.05		36	.03	5	40	1.05		6	.03	84	88.1
7	6	39	1.05		8	.03	6	38	1.05		38	.03	6	37	1.05		8	.03	83	87.8
8	7	36	1.05		10	.05	7	35	1.05		40	.05	7	34	1.07		10	.05	82	87.4
9	8	33	1.05		13	.05	8	32	1.05		43	.05	8	30	1.05		13	.05	81	87.1
10	9	30	1.05		16	0.05	9	29	1.05		46	0.05	9	27	1.05		16	0.07	**80**	86.8
11	10	27	1.05		19	.07	10	26	1.07		49	.07	10	24	1.07		20	.07	79	86.5
12	11	24	1.05		23	.07	11	22	1.05		53	.07	11	20	1.05		24	.07	78	86.1
13	12	21	1.05		27	.07	12	19	1.05		57	.07	12	17	1.07		28	.07	77	85.8
14	13	18	1.05		31	.08	13	16	1.07	19	1	.08	13	13	1.05		32	.08	76	85.5
15	14	15	1.05		36	0.08	14	12	1.05		6	0.08	14	10	1.07		37	0.08	75	85.1
16	15	12	1.05		41	.08	15	9	1.05		11	.10	15	6	1.05		42	.10	74	84.8
17	16	9	1.05		46	.10	16	6	1.07		17	.10	16	3	1.07		48	.10	73	84.5
18	17	6	1.07		52	.10	17	2	1.05		23	.10		59	1.05		54	.12	72	84.1
19	18	2	1.05		58	.10		59	1.05		29	.12	17	56	1.07	20	1	.12	71	83.8
20		59	1.05	19	4	0.12	18	56	1.07		36	0.12	18	52	1.07		8	0.12	**70**	83.4
21	19	56	1.07		11	.13	19	52	1.05		43	.13	19	48	1.05		15	.12	69	83.1
22	20	52	1.05		19	.13	20	49	1.07		51	.13	20	45	1.07		22	.13	68	82.7
23	21	49	1.07		27	.13	21	45	1.07		59	.13	21	41	1.07		30	.15	67	82.3
24	22	45	1.05		35	.13	22	41	1.05	20	7	.15	22	37	1.07		39	.15	66	82.0
25	23	42	1.07		43	0.15	23	38	1.07		16	0.15	23	33	1.07		48	0.17	65	81.6
26	24	38	1.05		52	.17	24	34	1.07		25	.17	24	29	1.07		58	.17	64	81.2
27	25	35	1.07	20	2	.17	25	30	1.07		35	.17	25	25	1.07	21	8	.17	63	80.8
28	26	31	1.07		12	.18	26	26	1.07		45	.18	26	21	1.07		18	.18	62	80.4
29	27	27	1.05		23	.18	27	22	1.07		56	.18	27	17	1.07		29	.20	61	80.0
30	28	24	1.07		34	0.20	28	18	1.07	21	7	0.20	28	13	1.07		41	0.20	**60**	79.6
31	29	20	1.07		46	.20	29	14	1.07		19	.22	29	9	1.09		53	.22	59	79.2
32	30	16	1.07		58	.22	30	10	1.07		32	.22	30	4	1.07	22	6	.22	58	78.8
33	31	12	1.07	21	11	.22	31	6	1.07		45	.23	31	0	1.09		19	.23	57	78.4
34	32	8	1.07		24	.23	32	2	1.09		59	.23		55	1.07		33	.25	56	77.9
35	33	4	1.09		38	0.25		57	1.07	22	13	0.25	32	51	1.09		48	0.25	**55**	77.5
36		59	1.07		53	.25	33	53	1.09		28	.27	33	46	1.09	23	3	.27	54	77.0
37	34	55	1.09	22	8	.27	34	48	1.09		44	.28	34	41	1.09		19	.28	53	76.6
38	35	50	1.07		24	.28	35	43	1.09	23	1	.28	35	36	1.09		36	.30	52	76.1
39	36	46	1.09		41	.30	36	38	1.09		18	.30	36	31	1.09		54	.30	51	75.6
40	37	41	1.09		59	0.32	37	33	1.09		36	0.32	37	26	1.11	24	12	0.33	**50**	75.1
41	38	36	1.09	23	18	.32	38	28	1.09		55	.32	38	20	1.09		32	.33	49	74.6
42	39	31	1.09		37	.33	39	23	1.09	24	14	.35	39	15	1.11		52	.35	48	74.1
43	40	26	1.09		57	.35	40	18	1.11		35	.37	40	9	1.11	25	13	.37	47	73.5
44	41	21	1.09	24	18	.38	41	12	1.09		57	.37	41	3	1.11		35	.38	46	73.0
45	42	16			41		42	7		25	19			57			58		45	72.4
t	a	60′/Δ	b	Δ/60′			a	60′/Δ	b	Δ/60′			a	60′/Δ	b	Δ/60′				a
	d = 18° 0′						d = 18° 30′						d = 19° 0′							

b / B	a = 18° 0′ h	d	60′/Δ	Z	t	Δ/60′	a = 18° 30′ h	d	60′/Δ	Z	t	Δ/60′	a = 19° 0′ h	d	60′/Δ	Z	t	Δ/60′	c / C	a / β
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
45	42 16		1.11	24 41		0.38	42 7		1.11	25 19		0.40	41 57		1.11	25 58		0.40	45	72.4
46	43 10		1.11	25 4		.40	43 1		1.11	43		.42	42 51		1.11	26 22		.42	44	71.8
47	44 4		1.11	28		.43	55		1.11	26 8		.43	43 45		1.11	47		.45	43	71.2
48	58		1.11	54		.45	44 49		1.13	34		.45	44 39		1.13	27 14		.47	42	70.6
49	45 52		1.11	26 21		.47	45 42		1.13	27 1		.48	45 32		1.13	42		.48	41	69.9
50	46 46		1.13	49		0.48	46 35		1.13	30		0.50	46 25		1.13	28 11		0.50	40	69.3
51	47 39		1.13	27 18		.52	47 28		1.13	28 0		.52	47 18		1.15	41		.53	39	68.6
52	48 32		1.13	49		.55	48 21		1.13	31		.55	48 10		1.15	29 13		.57	38	67.9
53	49 25		1.13	28 22		.57	49 14		1.15	29 4		.58	49 2		1.15	47		.58	37	67.2
54	50 18		1.15	56		.60	50 6		1.15	39		.60	54		1.15	30 22		.62	36	66.4
55	51 10		1.15	29 32		0.63	58		1.15	30 15		0.65	50 46		1.18	59		0.63	35	65.6
56	52 2		1.15	30 10		.65	51 50		1.18	54		.67	51 37		1.18	31 37		.68	34	64.8
57	54		1.15	49		.70	52 41		1.18	31 34		.70	52 28		1.20	32 18		.72	33	64.0
58	53 46		1.18	31 31		.73	53 32		1.18	32 16		.75	53 18		1.20	33 1		.75	32	63.1
59	54 37		1.20	32 15		.77	54 23		1.20	33 1		.77	54 8		1.20	46		.78	31	62.2
60	55 27		1.20	33 1		0.82	55 13		1.22	47		0.83	58		1.22	34 33		0.83	30	61.2
61	56 17		1.20	50		.85	56 2		1.22	34 37		.87	55 47		1.22	35 23		.88	29	60.2
62	57 7		1.22	34 41		.90	51		1.22	35 29		.90	56 36		1.25	36 16		.92	28	59.2
63	56		1.25	35 35		.97	57 40		1.25	36 23		.97	57 24		1.28	37 11		.97	27	58.1
64	58 44		1.25	36 33		1.00	58 28		1.28	37 21		1.02	58 11		1.28	38 9		1.02	26	57.0
65	59 32		1.28	37 33		1.07	59 15		1.28	38 22		1.07	58		1.30	39 10		1.08	25	55.8
66	60 19		1.28	38 37		1.13	60 2		1.30	39 26		1.13	59 44		1.30	40 15		1.13	24	54.5
67	61 6		1.30	39 45		1.18	48		1.33	40 34		1.20	60 30		1.33	41 23		1.20	23	53.2
68	52		1.33	40 56		1.27	61 33		1.33	41 46		1.27	61 15		1.40	42 35		1.27	22	51.9
69	62 37		1.36	42 12		1.33	62 18		1.40	43 2		1.33	58		1.40	43 51		1.33	21	50.4
70	63 21		1.40	43 32		1.40	63 1		1.43	44 22		1.42	62 41		1.43	45 11		1.42	20	48.9
71	64 4		1.46	44 56		1.50	43		1.43	45 47		1.50	63 23		1.46	46 36		1.50	19	47.3
72	45		1.46	46 26		1.58	64 25		1.50	47 17		1.57	64 4		1.54	48 6		1.57	18	45.7
73	65 26		1.50	48 1		1.68	65 5		1.54	48 51		1.67	43		1.58	49 40		1.65	17	43.9
74	66 6		1.58	49 42		1.77	44		1.62	50 31		1.77	65 21		1.62	51 19		1.75	16	42.1
75	44		1.67	51 28		1.87	66 21		1.67	52 17		1.85	58		1.71	53 4		1.85	15	40.2
76	67 20		1.71	53 20		1.97	57		1.76	54 8		1.95	66 33		1.76	54 55		1.93	14	38.2
77	55		1.76	55 18		2.08	67 31		1.82	56 5		2.05	67 7		1.88	56 51		2.03	13	36.0
78	68 29		1.94	57 23		2.20	68 4		1.94	58 8		2.17	39		2.00	58 53		2.12	12	33.8
79	69 0		2.07	59 35		2.30	35		2.14	60 18		2.27	68 9		2.14	61 0		2.23	11	31.5
80	29		2.22	61 53		2.42	69 3		2.22	62 34		2.38	37		2.31	63 14		2.33	10	29.1
81	56		2.40	64 18		2.52	30		2.50	64 57		2.47	69 3		2.50	65 34		2.43	9	26.5
82	70 21		2.61	66 49		2.62	54		2.73	67 25		2.57	27		2.86	68 0		2.52	8	23.9
83	44		3.16	69 26		2.73	70 16		3.16	69 59		2.67	48		3.16	70 31		2.60	7	21.2
84	71 3		3.53	72 10		2.82	35		3.53	72 39		2.75	70 7		3.75	73 7		2.68	6	18.3
85	20		4.00	74 59		2.90	52		4.62	75 24		2.82	23		4.62	75 48		2.75	5	15.4
86	35		5.45	77 53		2.97	71 5		5.45	78 13		2.90	36		6.00	78 33		2.82	4	12.4
87	46		7.50	80 51		3.02	16		7.50	81 7		2.93	46		7.50	81 22		2.85	3	9.4
88	54		15.0	83 52		3.05	24		15.0	84 3		2.97	54		15.0	84 13		2.88	2	6.3
89	58		30.0	86 55		3.08	28		30.0	87 1		2.98	58		30.0	87 6		2.90	1	3.1
90	72 0			90 0			30			90 0			71 0			90 0			0	0.0
t	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′		a
	d = 18° 0′						d = 18° 30′						d = 19° 0′							

b / B	a = 19° 30′						a = 20° 0′						a = 20° 30′						c / C	a / β
	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′		
°	°	′		°	′		°	′		°	′		°	′		°	′		°	°
0	0	0	1.05	19	30	0.00	0	0	1.07	20	0	0.00	0	0	1.07	20	30	0.00	90	90.0
1		57	1.07		30	.02		56	1.05		0	.02		56	1.07		30	.02	89	89.7
2	1	53	1.05		31	.02	1	53	1.07		1	.02	1	52	1.05		31	.02	88	89.3
3	2	50	1.07		32	.02	2	49	1.05		2	.02	2	49	1.07		32	.02	87	89.0
4	3	46	1.05		33	.02	3	46	1.07		3	.02	3	45	1.07		33	.02	86	88.6
5	4	43	1.07		34	0.03	4	42	1.07		4	0.03	4	41	1.07		34	0.03	85	88.3
6	5	39	1.05		36	.03	5	38	1.05		6	.03	5	37	1.07		36	.03	84	87.9
7	6	36	1.07		38	.05	6	35	1.07		8	.05	6	33	1.07		38	.05	83	87.6
8	7	32	1.05		41	.05	7	31	1.07		11	.05	7	29	1.05		41	.05	82	87.2
9	8	29	1.07		44	.05	8	27	1.07		14	.05	8	26	1.07		44	.05	81	86.9
10	9	25	1.05		47	0.05	9	23	1.05		17	0.07	9	22	1.07		47	0.07	80	86.5
11	10	22	1.07		50	.07	10	20	1.07		21	.07	10	18	1.07		51	.07	79	86.2
12	11	18	1.05		54	.07	11	16	1.07		25	.07	11	14	1.07		55	.08	78	85.8
13	12	15	1.07		58	.08	12	12	1.07		29	.08	12	10	1.07	21	0	.08	77	85.5
14	13	11	1.07	20	3	.08	13	8	1.05		34	.08	13	6	1.07		5	.08	76	85.1
15	14	7	1.05		8	0.08	14	5	1.07		39	0.08	14	2	1.07		10	0.08	75	84.8
16	15	4	1.07		13	.10	15	1	1.07		44	.10		58	1.07		15	.10	74	84.4
17	16	0	1.07		19	.10		57	1.07		50	.10	15	54	1.09		21	.12	73	84.0
18		56	1.07		25	.12	16	53	1.07		56	.12	16	49	1.07		28	.12	72	83.7
19	17	52	1.07		32	.12	17	49	1.07	21	3	.12	17	45	1.07		35	.12	71	83.3
20	18	48	1.05		39	0.12	18	45	1.07		10	0.13	18	41	1.07		42	0.13	70	82.9
21	19	45	1.07		46	.13	19	41	1.07		18	.13	19	37	1.09		50	.13	69	82.5
22	20	41	1.07		54	.13	20	37	1.09		26	.13	20	32	1.07		58	.13	68	82.1
23	21	37	1.07	21	2	.15	21	32	1.07		34	.15	21	28	1.07	22	6	.15	67	81.7
24	22	33	1.07		11	.15	22	28	1.07		43	.17	22	24	1.09		15	.17	66	81.3
25	23	29	1.07		20	0.17	23	24	1.07		53	0.17	23	19	1.07		25	0.17	65	80.9
26	24	25	1.09		30	.17	24	20	1.09	22	3	.17	24	15	1.09		35	.18	64	80.5
27	25	20	1.07		40	.18	25	15	1.07		13	.18	25	10	1.09		46	.18	63	80.1
28	26	16	1.07		51	.18	26	11	1.09		24	.20	26	5	1.09		57	.20	62	79.7
29	27	12	1.09	22	2	.20	27	6	1.07		36	.20	27	0	1.09	23	9	.20	61	79.3
30	28	7	1.07		14	0.22	28	2	1.09		48	0.22		55	1.09		21	0.22	60	78.8
31	29	3	1.09		27	.22		57	1.09	23	1	.22	28	50	1.09		34	.23	59	78.4
32		58	1.07		40	.23	29	52	1.09		14	.23	29	45	1.09		48	.23	58	77.9
33	30	54	1.09		54	.23	30	47	1.09		28	.23	30	40	1.09	24	2	.25	57	77.5
34	31	49	1.09	23	8	.25	31	42	1.09		42	.25	31	35	1.09		17	.25	56	77.0
35	32	44	1.09		23	0.27	32	37	1.09		57	0.27	32	30	1.11		32	0.27	55	76.5
36	33	39	1.09		39	.27	33	32	1.11	24	13	.28	33	24	1.09		48	.28	54	76.0
37	34	34	1.09		55	.28	34	26	1.09		30	.30	34	19	1.11	25	5	.30	53	75.5
38	35	29	1.11	24	12	.30	35	21	1.11		48	.30	35	13	1.11		23	.32	52	75.0
39	36	23	1.09		30	.32	36	15	1.11	25	6	.32	36	7	1.11		42	.32	51	74.5
40	37	18	1.11		49	0.32	37	9	1.11		25	0.33	37	1	1.11	26	1	0.33	50	74.0
41	38	12	1.11	25	8	.35	38	3	1.11		45	.35		55	1.11		21	.35	49	73.4
42	39	6	1.11		29	.35		57	1.11	26	6	.35	38	49	1.13		42	.38	48	72.9
43	40	0	1.11		50	.38	39	51	1.11		27	.38	39	42	1.11	27	5	.38	47	72.3
44		54	1.11	26	13	.38	40	45	1.11		50	.40	40	36	1.13		28	.40	46	71.7
45	41	48			36		41	39		27	14		41	29			52		45	71.1
t	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′		a
	d = 19° 30′						d = 20° 0′						d = 20° 30′							

b / B	a = 19° 30′ h	d	60′/Δ	Z	t	Δ/60′	a = 20° 0′ h	d	60′/Δ	Z	t	Δ/60′	a = 20° 30′ h	d	60′/Δ	Z	t	Δ/60′	c / C	a / β
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
45	41 48		1.11	26 36		0.42	41 39		1.13	27 14		0.42	41 29		1.13	27 52		0.42	45	71.1
46	42 42		1.13	27 1		.42	42 32		1.13		39	.43	42 22		1.13	28 17		.45	44	70.5
47	43 35		1.13		26	.45	43 25		1.13	28 5		.47	43 15		1.15		44	.47	43	69.9
48	44 28		1.13		53	.48	44 18		1.15		33	.47	44 7		1.15	29 12		.48	42	69.2
49	45 21		1.13	28 22		.48	45 10		1.15	29 1		.50		59	1.15		41	.50	41	68.5
50	46 14		1.15		51	0.52	46 2		1.15		31	0.53	45 51		1.15	30 11		0.53	40	67.8
51	47 6		1.15	29 22		.53		54	1.15	30 3		.55	46 43		1.18		43	.55	39	67.1
52		58	1.15		54	.57	47 46		1.15		36	.57	47 34		1.18	31 16		.58	38	66.4
53	48 50		1.15	30 28		.60	48 38		1.18	31 10		.60	48 25		1.18		51	.62	37	65.6
54	49 42		1.18	31 4		.63	49 29		1.18		46	.63	49 16		1.18	32 28		.63	36	64.8
55	50 33		1.18		42	0.65	50 20		1.20	32 24		0.65	50 7		1.20	33 6		0.67	35	64.0
56	51 24		1.20	32 21		.68	51 10		1.20	33 3		.70		57	1.22		46	.70	34	63.1
57	52 14		1.20	33 2		.72	52 0		1.20		45	.73	51 46		1.22	34 28		.73	33	62.2
58	53 4		1.20		45	.77		50	1.22	34 29		.77	52 35		1.22	35 12		.78	32	61.3
59		54	1.22	34 31		.80	53 39		1.22	35 15		.80	53 24		1.22		59	.80	31	60.3
60	54 43		1.22	35 19		0.83	54 28		1.25	36 3		0.85	54 13		1.25	36 47		0.85	30	59.3
61	55 32		1.25	36 9		.88	55 16		1.25		54	.88	55 1		1.28	37 38		.90	29	58.3
62	56 20		1.25	37 2		.92	56 4		1.28	37 47		.93		48	1.30	38 32		.95	28	57.2
63	57 8		1.28		57	.98		51	1.28	38 43		.98	56 34		1.30	39 29		.98	27	56.1
64		55	1.30	38 56		1.03	57 38		1.30	39 42		1.03	57 20		1.30	40 28		1.03	26	55.0
65	58 41		1.30	39 58		1.08	58 24		1.33	40 44		1.08	58 6		1.36	41 30		1.08	25	53.7
66	59 27		1.33	41 3		1.13	59 9		1.36	41 49		1.15		50	1.36	42 35		1.15	24	52.5
67	60 12		1.36	42 11		1.20		53	1.40	42 58		1.22	59 34		1.40	43 44		1.22	23	51.1
68		56	1.40	43 23		1.27	60 36		1.40	44 11		1.27	60 17		1.43	44 57		1.27	22	49.7
69	61 39		1.43	44 39		1.35	61 19		1.43	45 27		1.33		59	1.46	46 13		1.33	21	48.3
70	62 21		1.46	46 0		1.40	62 1		1.50	46 47		1.40	61 40		1.50	47 33		1.40	20	46.8
71	63 2		1.50	47 24		1.48		41	1.50	48 11		1.48	62 20		1.54	48 57		1.48	19	45.2
72		42	1.54	48 53		1.57	63 21		1.58	49 40		1.57		59	1.62	50 26		1.55	18	43.5
73	64 21		1.58	50 27		1.65		59	1.62	51 14		1.63	63 36		1.67	51 59		1.62	17	41.8
74		59	1.67	52 6		1.73	64 36		1.71	52 52		1.72	64 12		1.71	53 36		1.70	16	40.0
75	65 35		1.76	53 50		1.83	65 11		1.76	54 35		1.80		47	1.76	55 18		1.80	15	38.1
76	66 9		1.82	55 40		1.92		45	1.82	56 23		1.90	65 21		1.88	57 6		1.87	14	36.1
77		42	1.88	57 35		2.00	66 18		2.00	58 17		1.98		53	2.00	58 58		1.95	13	34.0
78	67 14		2.07	59 35		2.10		48	2.07	60 16		2.07	66 23		2.14	60 55		2.05	12	31.9
79		43	2.14	61 41		2.20	67 17		2.22	62 20		2.17		51	2.31	62 58		2.12	11	29.6
80	68 11		2.40	63 53		2.28		44	2.40	64 30		2.25	67 17		2.50	65 5		2.22	10	27.3
81		36	2.61	66 10		2.38	68 9		2.73	66 45		2.33		41	2.73	67 18		2.28	9	24.8
82		59	2.86	68 33		2.47		31	3.00	69 5		2.40	68 3		3.00	69 35		2.37	8	22.3
83	69 20		3.33	71 1		2.53		51	3.33	71 29		2.50		23	3.33	71 57		2.43	7	19.7
84		38	3.75	73 33		2.62	69 9		3.75	73 59		2.55		41	4.00	74 23		2.50	6	17.1
85		54	4.62	76 10		2.68		25	5.00	76 32		2.62		56	5.00	76 53		2.55	5	14.3
86	70 7		6.00	78 51		2.75		37	6.00	79 9		2.67	69 8		6.67	79 26		2.60	4	11.6
87		17	8.57	81 36		2.77		47	8.57	81 49		2.70		17	8.57	82 2		2.63	3	8.7
88		24	12.0	84 22		2.82		54	12.0	84 31		2.73		24	12.0	84 40		2.67	2	5.8
89		29	60.0	87 11		2.82		59	60.0	87 15		2.75		29	60.0	87 20		2.67	1	2.9
90		30		90 0			70 0			90 0				30		90 0			0	0.0

t	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a
	d = 19° 30′				d = 20° 0′				d = 20° 30′				

b / B	a = 21° 0′						a = 21° 30′						a = 22° 0′						c / C	a / β
	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′		
°	°	′		°	′		°	′		°	′		°	′		°	′		°	°
0	0	0	1.07	21	0	0.00	0	0	1.07	21	30	0.00	0	0	1.07	22	0	0.00	90	90.0
1		56	1.07		0	.02		56	1.07		30	.02		56	1.09		0	.02	89	89.6
2	1	52	1.07		1	.02	1	52	1.09		31	.02	1	51	1.07		1	.02	88	89.3
3	2	48	1.07		2	.02	2	47	1.07		32	.02	2	47	1.09		2	.02	87	88.9
4	3	44	1.07		3	.02	3	43	1.07		33	.02	3	42	1.07		3	.03	86	88.5
5	4	40	1.07		4	0.03	4	39	1.07		34	0.03	4	38	1.07		5	0.03	85	88.2
6	5	36	1.07		6	.05	5	35	1.07		36	.05	5	34	1.09		7	.03	84	87.8
7	6	32	1.07		9	.03	6	31	1.09		39	.05	6	29	1.07		9	.05	83	87.4
8	7	28	1.07		11	.05	7	26	1.07		42	.05	7	25	1.09		12	.05	82	87.1
9	8	24	1.07		14	.07	8	22	1.07		45	.05	8	20	1.07		15	.05	81	86.7
10	9	20	1.07		18	0.07	9	18	1.07		48	0.07	9	16	1.09		18	0.07	80	86.3
11	10	16	1.07		22	.07	10	14	1.09		52	.07	10	11	1.07		22	.07	79	85.9
12	11	12	1.09		26	.07	11	9	1.07		56	.08	11	7	1.09		26	.08	78	85.5
13	12	7	1.07		30	.08	12	5	1.09	22	1	.08	12	2	1.07		31	.08	77	85.2
14	13	3	1.07		35	.08	13	0	1.07		6	.08		58	1.09		36	.10	76	84.8
15		59	1.07		40	0.10		56	1.07		11	0.10	13	53	1.09		42	0.10	75	84.4
16	14	55	1.09		46	.10	14	52	1.09		17	.10	14	48	1.07		48	.10	74	84.0
17	15	50	1.07		52	.12	15	47	1.07		23	.12	15	44	1.09		54	.12	73	83.6
18	16	46	1.07		59	.12	16	43	1.09		30	.12	16	39	1.09	23	1	.12	72	83.2
19	17	42	1.09	22	6	.12	17	38	1.09		37	.13	17	34	1.09		8	.13	71	82.8
20	18	37	1.07		13	0.13	18	33	1.07		45	0.13	18	29	1.09		16	0.13	70	82.4
21	19	33	1.09		21	.13	19	29	1.09		53	.13	19	24	1.09		24	.15	69	82.0
22	20	28	1.07		29	.15	20	24	1.09	23	1	.15	20	19	1.09		33	.15	68	81.6
23	21	24	1.09		38	.15	21	19	1.09		10	.17	21	14	1.09		42	.17	67	81.2
24	22	19	1.09		47	.17	22	14	1.09		20	.17	22	9	1.09		52	.17	66	80.7
25	23	14	1.09		57	0.18	23	9	1.09		30	0.17	23	4	1.09	24	2	0.17	65	80.3
26	24	9	1.09	23	8	.18	24	4	1.09		40	.18		59	1.09		12	.18	64	79.9
27	25	4	1.09		19	.18		59	1.09		51	.20	24	54	1.11		23	.20	63	79.4
28		59	1.09		30	.20	25	54	1.09	24	3	.20	25	48	1.09		35	.22	62	79.0
29	26	54	1.09		42	.20	26	49	1.11		15	.22	26	43	1.11		48	.22	61	78.5
30	27	49	1.09		54	0.22	27	43	1.09		28	0.22	27	37	1.09	25	1	0.22	60	78.1
31	28	44	1.09	24	7	.23	28	38	1.09		41	.23	28	32	1.11		14	.23	59	77.6
32	29	39	1.09		21	.25	29	33	1.11		55	.25	29	26	1.11		28	.25	58	77.1
33	30	34	1.11		36	.25	30	27	1.11	25	10	.25	30	20	1.11		43	.27	57	76.6
34	31	28	1.09		51	.27	31	21	1.11		25	.27	31	14	1.11		59	.27	56	76.1
35	32	23	1.11	25	7	0.27	32	15	1.11		41	0.28	32	8	1.13	26	15	0.28	55	75.6
36	33	17	1.11		23	.28	33	9	1.11		58	.28	33	1	1.11		32	.30	54	75.1
37	34	11	1.11		40	.30	34	3	1.11	26	15	.30		55	1.13		50	.32	53	74.6
38	35	5	1.11		58	.32		57	1.13		33	.33	34	48	1.11	27	9	.32	52	74.0
39		59	1.11	26	17	.33	35	50	1.11		53	.33	35	42	1.13		28	.33	51	73.5
40	36	53	1.13		37	0.35	36	44	1.13	27	13	0.35	36	35	1.13		48	0.37	50	72.9
41	37	46	1.11		58	.35	37	37	1.13		34	.37	37	28	1.13	28	10	.37	49	72.3
42	38	40	1.13	27	19	.38	38	30	1.13		56	.37	38	21	1.15		32	.38	48	71.7
43	39	33	1.13		42	.38	39	23	1.13	28	18	.40	39	13	1.13		55	.40	47	71.1
44	40	26	1.13	28	5	.42	40	16	1.15		42	.42	40	6	1.15	29	19	.42	46	70.5
45	41	19			30		41	8		29	7			58			44		45	69.9
t	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′		a
	d = 21° 0′						d = 21° 30′						d = 22° 0′							

b / B	a = 21° 0′						a = 21° 30′						a = 22° 0′						c / C	a / β
	h \ d	60′/Δ		Z \ t		Δ/60′	h \ d	60′/Δ		Z \ t		Δ/60′	h \ d	60′/Δ		Z \ t		Δ/60′		
	° ′			°			° ′			°			° ′			°				
45	41 19	1.15		28 30		0.42	41 8	1.13		29 7		0.43	40 58	1.15		29 44		0.45	45	69.9
46	42 11	1.13			55	.45	42 1	1.15			33	.47	41 50	1.15		30 11		.47	44	69.2
47	43 4	1.15		29 22		.47	53	1.15		30 1		.47	42 42	1.18			39	.48	43	68.5
48	56	1.15			50	.50	43 45	1.18			29	.50	43 33	1.18		31 8		.50	42	67.8
49	44 48	1.15		30 20		.52	44 36	1.18			59	.52	44 24	1.18			38	.52	41	67.1
50	45 40	1.18			51	0.53	45 27	1.18		31 30		0.55	45 15	1.18		32 9		0.55	40	66.4
51	46 31	1.18		31 23		.57	46 18	1.18		32 3		.57	46 6	1.20			42	.58	39	65.6
52	47 22	1.18			57	.58	47 9	1.18			37	.58	56	1.20		33 17		.60	38	64.9
53	48 13	1.20		32 32		.62	48 0	1.20		33 12		.63	47 46	1.20			53	.62	37	64.1
54	49 3	1.20		33 9		.65	50	1.22			50	.65	48 36	1.22		34 30		.67	36	63.2
55	53	1.20			48	0.67	49 39	1.22		34 29		0.68	49 25	1.22		35 10		0.68	35	62.4
56	50 43	1.22		34 28		.72	50 28	1.22		35 10		.72	50 14	1.25			51	.72	34	61.5
57	51 32	1.22		35 11		.73	51 17	1.22			53	.75	51 2	1.25		36 34		.75	33	60.6
58	52 21	1.25			55	.78	52 6	1.25		36 38		.78	50	1.25		37 19		.80	32	59.6
59	53 9	1.25		36 42		.82	54	1.28		37 25		.82	52 38	1.28		38 7		.82	31	58.6
60	57	1.28		37 31		0.85	53 41	1.28		38 14		0.87	53 25	1.30			56	0.87	30	57.6
61	54 44	1.28		38 22		.90	54 28	1.30		39 6		.90	54 11	1.30		39 48		.92	29	56.5
62	55 31	1.30		39 16		.95	55 14	1.30		40 0		.95	57	1.33		40 43		.95	28	55.4
63	56 17	1.30		40 13		1.00	56 0	1.33			57	1.00	55 42	1.33		41 40		1.00	27	54.3
64	57 3	1.33		41 13		1.03	45	1.36		41 57		1.03	56 27	1.36		42 40		1.05	26	53.1
65	48	1.36		42 15		1.10	57 29	1.40		42 59		1.10	57 11	1.40		43 43		1.10	25	51.8
66	58 32	1.40		43 21		1.15	58 12	1.40		44 5		1.15	54	1.43		44 49		1.15	24	50.5
67	59 15	1.43		44 30		1.20	55	1.43		45 14		1.20	58 36	1.46		45 58		1.20	23	49.2
68	57	1.43		45 42		1.27	59 37	1.46		46 26		1.27	59 17	1.50		47 10		1.27	22	47.8
69	60 39	1.50		46 58		1.33	60 18	1.50		47 42		1.33	57	1.54		48 26		1.32	21	46.3
70	61 19	1.54		48 18		1.40	58	1.54		49 2		1.40	60 36	1.58		49 45		1.38	20	44.8
71	58	1.58		49 42		1.47	61 37	1.62		50 26		1.45	61 14	1.62		51 8		1.45	19	43.2
72	62 36	1.62		51 10		1.53	62 14	1.62		51 53		1.53	51	1.67		52 35		1.53	18	41.6
73	63 13	1.67		52 42		1.62	51	1.71		53 25		1.60	62 27	1.71		54 7		1.58	17	39.8
74	49	1.76		54 19		1.70	63 26	1.82		55 1		1.68	63 2	1.82		55 42		1.65	16	38.0
75	64 23	1.82		56 1		1.77	59	1.82		56 42		1.75	35	1.88		57 21		1.73	15	36.2
76	56	1.94		57 47		1.85	64 32	2.00		58 27		1.82	64 7	2.00		59 5		1.80	14	34.2
77	65 27	2.00		59 38		1.93	65 2	2.07		60 16		1.90	37	2.14		60 53		1.88	13	32.2
78	57	2.14		61 34		2.00	31	2.22		62 10		1.98	65 5	2.22		62 46		1.95	12	30.1
79	66 25	2.40		63 34		2.10	58	2.40		64 9		2.07	32	2.50		64 43		2.02	11	27.9
80	50	2.50		65 40		2.17	66 23	2.61		66 13		2.12	56	2.61		66 44		2.10	10	25.7
81	67 14	2.73		67 50		2.23	46	2.73		68 20		2.20	66 19	2.86		68 50		2.17	9	23.4
82	36	3.16		70 4		2.32	67 8	3.33		70 32		2.27	40	3.33		71 0		2.22	8	21.0
83	55	3.53		72 23		2.38	26	3.53		72 48		2.33	58	3.75		73 13		2.28	7	18.5
84	68 12	4.29		74 46		2.43	43	4.29		75 8		2.38	67 14	4.29		75 30		2.33	6	16.0
85	26	5.00		77 12		2.50	57	5.00		77 31		2.43	28	5.45		77 50		2.37	5	13.4
86	38	6.00		79 42		2.53	68 9	6.67		79 57		2.48	39	6.67		80 12		2.42	4	10.8
87	48	8.57		82 14		2.57	18	8.57		82 26		2.50	48	8.57		82 37		2.45	3	8.1
88	55	15.0		84 48		2.60	25	15.0		84 56		2.53	55	15.0		85 4		2.47	2	5.4
89	59	60.0		87 24		2.60	29	60.0		87 28		2.53	59	60.0		87 32		2.47	1	2.7
90	69 0			90 0			30			90 0			68 0			90 0			0	0.0
t	a	60′/Δ		b		Δ/60′	a	60′/Δ		b		Δ/60′	a	60′/Δ		b		Δ/60′		a
	d = 21° 0′						d = 21° 30′						d = 22° 0′							

b / B	a = 22° 30′						a = 23° 0′						a = 23° 30′						c / C	α / β
	d / h	60′/Δ		t / Z	Δ/60′		d / h	60′/Δ		t / Z	Δ/60′		d / h	60′/Δ		t / Z	Δ/60′			
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
0	0 0	1.09		22 30	0.00		0 0	1.09		23 0	0.00		0 0	1.09		23 30	0.00		90	90.0
1	55	1.07		30	.02		55	1.07		0	.02		55	1.09		30	.02		89	89.6
2	1 51	1.09		31	.02		1 51	1.09		1	.02		1 50	1.09		31	.02		88	89.2
3	2 46	1.07		32	.02		2 46	1.09		2	.02		2 45	1.09		32	.02		87	88.8
4	3 42	1.09		33	.03		3 41	1.09		3	.03		3 40	1.09		33	.03		86	88.4
5	4 37	1.07		35	0.03		4 36	1.09		5	0.03		4 35	1.09		35	0.03		85	88.0
6	5 33	1.09		37	.03		5 31	1.09		7	.03		5 30	1.09		37	.03		84	87.6
7	6 28	1.09		39	.05		6 26	1.07		9	.05		6 25	1.09		39	.05		83	87.3
8	7 23	1.07		42	.05		7 22	1.09		12	.05		7 20	1.09		42	.07		82	86.9
9	8 19	1.09		45	.07		8 17	1.09		15	.07		8 15	1.09		46	.05		81	86.5
10	9 14	1.09		49	0.07		9 12	1.09		19	0.07		9 10	1.09		49	0.07		80	86.1
11	10 9	1.09		53	.07		10 7	1.09		23	.07		10 5	1.09		53	.08		79	85.7
12	11 4	1.07		57	.08		11 2	1.09		27	.08		11 0	1.11		58	.08		78	85.3
13	12 0	1.09	23	2	.08		57	1.09		32	.10		54	1.09	24	3	.08		77	84.8
14	55	1.09		7	.10		12 52	1.09		38	.08		12 49	1.09		8	.10		76	84.4
15	13 50	1.09		13	0.10		13 47	1.09		43	0.10		13 44	1.09		14	0.10		75	84.0
16	14 45	1.09		19	.10		14 42	1.09		49	.12		14 39	1.11		20	.12		74	83.6
17	15 40	1.09		25	.12		15 37	1.09		56	.12		15 33	1.09		27	.12		73	83.2
18	16 35	1.09		32	.12		16 32	1.11	24	3	.13		16 28	1.11		34	.13		72	82.8
19	17 30	1.09		39	.13		17 26	1.09		11	.13		17 22	1.09		42	.13		71	82.3
20	18 25	1.09		47	0.13		18 21	1.09		19	0.13		18 17	1.11		50	0.13		70	81.9
21	19 20	1.09		55	.15		19 16	1.11		27	.15		19 11	1.09		58	.15		69	81.5
22	20 15	1.09	24	4	.17		20 10	1.09		36	.15		20 6	1.11	25	7	.17		68	81.0
23	21 10	1.11		14	.17		21 5	1.11		45	.17		21 0	1.11		17	.17		67	80.6
24	22 4	1.09		24	.17		59	1.09		55	.18		54	1.11		27	.18		66	80.1
25	59	1.09		34	0.18		22 54	1.11	25	6	0.18		22 48	1.11		38	0.18		65	79.7
26	23 54	1.11		45	.18		23 48	1.11		17	.18		23 42	1.11		49	.20		64	79.2
27	24 48	1.11		56	.20		24 42	1.11		28	.20		24 36	1.11	26	1	.20		63	78.7
28	25 42	1.09	25	8	.22		25 36	1.11		40	.22		25 30	1.11		13	.22		62	78.3
29	26 37	1.11		21	.22		26 30	1.11		53	.23		26 24	1.11		26	.23		61	77.8
30	27 31	1.11		34	0.23		27 24	1.11	26	7	0.23		27 18	1.13		40	0.23		60	77.3
31	28 25	1.11		48	.23		28 18	1.11		21	.23		28 11	1.11		54	.25		59	76.8
32	29 19	1.11	26	2	.25		29 12	1.13		35	.27		29 5	1.13	27	9	.25		58	76.3
33	30 13	1.11		17	.27		30 5	1.11		51	.27		58	1.13		24	.27		57	75.8
34	31 7	1.13		33	.28		59	1.13	27	7	.28		30 51	1.13		40	.28		56	75.2
35	32 0	1.11		50	0.28		31 52	1.13		24	0.28		31 44	1.13		57	0.30		55	74.7
36	54	1.13	27	7	.30		32 45	1.13		41	.30		32 37	1.13	28	15	.32		54	74.2
37	33 47	1.13		25	.32		33 38	1.13		59	.32		33 30	1.13		34	.32		53	73.6
38	34 40	1.13		44	.33		34 31	1.13	28	18	.33		34 23	1.15		53	.35		52	73.0
39	35 33	1.13	28	4	.33		35 24	1.13		38	.35		35 15	1.15	29	14	.35		51	72.4
40	36 26	1.13		24	0.35		36 17	1.15		59	0.37		36 7	1.15		35	0.37		50	71.8
41	37 19	1.15		45	.38		37 9	1.15	29	21	.38		59	1.15		57	.38		49	71.2
42	38 11	1.15	29	8	.40		38 1	1.15		44	.40		37 51	1.15	30	20	.40		48	70.6
43	39 3	1.15		32	.40		53	1.15	30	8	.42		38 43	1.18		44	.42		47	70.0
44	55	1.15		56	.43		39 45	1.15		33	.43		39 34	1.15	31	9	.43		46	69.3
45	40 47		30	22			40 37			59			40 26			35			45	68.7
t	a	60′/Δ		b	Δ/60′		a	60′/Δ		b	Δ/60′		a	60′/Δ		b	Δ/60′			α
	d = 22° 30′						d = 23° 0′						d = 23° 30′							

b / B	$a = 22° 30'$ h	d	60′/Δ	Z	t	Δ/60′	$a = 23° 0'$ h	d	60′/Δ	Z	t	Δ/60′	$a = 23° 30'$ h	d	60′/Δ	Z	t	Δ/60′	c / C	a / β
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
45	40 47		1.15	30 22		0.43	40 37		1.18	30 59		0.45	40 26		1.18	31 35		0.47	45	68.7
46	41 39		1.15		48	.47	41 28		1.18	31 26		.47	41 17		1.20	32 3		.47	44	68.0
47	42 31		1.18	31 16		.48	42 19		1.18		54	.48	42 7		1.18		31	.50	43	67.3
48	43 22		1.18		45	.52	43 10		1.20	32 23		.52		58	1.20	33 1		.52	42	66.5
49	44 13		1.20	32 16		.53	44 0		1.20		54	.53	43 48		1.20		32	.55	41	65.8
50	45 3		1.20		48	0.55		50	1.20	33 26		0.57	44 38		1.22	34 5		0.57	40	65.0
51		53	1.20	33 21		.58	45 40		1.20	34 0		.58	45 27		1.22		39	.58	39	64.2
52	46 43		1.20		56	.60	46 30		1.22		35	.62	46 16		1.22	35 14		.62	38	63.4
53	47 33		1.22	34 32		.63	47 19		1.22	35 12		.63	47 5		1.22		51	.65	37	62.6
54	48 22		1.22	35 10		.67	48 8		1.25		50	.67		54	1.25	36 30		.67	36	61.7
55	49 11		1.25		50	0.70		56	1.25	36 30		0.70	48 42		1.28	37 10		0.70	35	60.8
56		59	1.25	36 32		.72	49 44		1.25	37 12		.73	49 29		1.28		52	.73	34	59.9
57	50 47		1.25	37 15		.77	50 32		1.28		56	.77	50 16		1.28	38 36		.77	33	59.0
58	51 35		1.28	38 1		.78	51 19		1.28	38 42		.80	51 3		1.30	39 22		.80	32	58.0
59	52 22		1.30		48	.83	52 6		1.30	39 30		.83		49	1.30	40 10		.85	31	57.0
60	53 8		1.30	39 38		0.88		52	1.33	40 20		0.87	52 35		1.33	41 1		0.87	30	55.9
61		54	1.30	40 31		.90	53 37		1.33	41 12		.92	53 20		1.36		53	.92	29	54.8
62	54 40		1.36	41 25		.97	54 22		1.36	42 7		.97	54 4		1.36	42 48		.97	28	53.7
63	55 24		1.36	42 23		1.00	55 6		1.40	43 5		1.00		48	1.40	43 46		1.00	27	52.5
64	56 8		1.40	43 23		1.05		49	1.40	44 5		1.05	55 31		1.43	44 46		1.05	26	51.3
65		51	1.40	44 26		1.08	56 32		1.43	45 8		1.08	56 13		1.46	45 49		1.10	25	50.0
66	57 34		1.43	45 31		1.15	57 14		1.46	46 13		1.15		54	1.46	46 55		1.13	24	48.7
67	58 16		1.50	46 40		1.20		55	1.50	47 22		1.20	57 35		1.50	48 3		1.20	23	47.4
68		56	1.50	47 52		1.27	58 35		1.50	48 34		1.27	58 15		1.58	49 15		1.25	22	46.0
69	59 36		1.54	49 8		1.32	59 15		1.58	49 50		1.30		53	1.58	50 30		1.32	21	44.5
70	60 15		1.62	50 27		1.38		53	1.62	51 8		1.38	59 31		1.62	51 49		1.37	20	43.0
71		52	1.62	51 50		1.45	60 30		1.67	52 31		1.43	60 8		1.71	53 11		1.42	19	41.4
72	61 29		1.71	53 17		1.50	61 6		1.71	53 57		1.50		43	1.76	54 36		1.48	18	39.7
73	62 4		1.76	54 47		1.57		41	1.82	55 27		1.55	61 17		1.82	56 5		1.55	17	38.0
74		38	1.82	56 21		1.65	62 14		1.88	57 0		1.63		50	1.94	57 38		1.60	16	36.3
75	63 11		1.94	58 0		1.72		46	2.00	58 38		1.68	62 21		2.00	59 14		1.68	15	34.4
76		42	2.07	59 43		1.78	63 16		2.07	60 19		1.77		51	2.14	60 55		1.73	14	32.5
77	64 11		2.14	61 30		1.85		45	2.14	62 5		1.82	63 19		2.22	62 39		1.80	13	30.6
78		39	2.31	63 21		1.92	64 13		2.40	63 54		1.90		46	2.40	64 27		1.85	12	28.5
79	65 5		2.50	65 16		1.98		38	2.50	65 48		1.95	64 11		2.61	66 18		1.93	11	26.4
80		29	2.73	67 15		2.07	65 2		2.86	67 45		2.02		34	2.73	68 14		1.98	10	24.3
81		51	3.00	69 19		2.12		23	3.00	69 46		2.08		56	3.16	70 13		2.03	9	22.1
82	66 11		3.33	71 26		2.17		43	3.33	71 51		2.13	65 15		3.53	72 15		2.10	8	19.8
83		29	3.75	73 36		2.23	66 1		4.00	73 59		2.18		32	4.00	74 21		2.13	7	17.4
84		45	4.29	75 50		2.28		16	4.62	76 10		2.23		47	4.62	76 29		2.18	6	15.1
85		59	5.45	78 7		2.32		29	5.45	78 24		2.27	66 0		5.45	78 40		2.22	5	12.0
86	67 10		6.67	80 26		2.37		40	6.67	80 40		2.30		11	7.50	80 53		2.25	4	10.1
87		19	10.0	82 48		2.38		49	10.0	82 58		2.33		19	10.0	83 8		2.28	3	7.6
88		25	15.0	85 11		2.40		55	15.0	85 18		2.35		25	15.0	85 25		2.28	2	5.1
89		29	60.0	87 35		2.42		59	60.0	87 39		2.35		29	60.0	87 42		2.30	1	2.6
90		30		90 0			67 0			90 0				30		90 0			0	0.0
t	a	60′/Δ		b	Δ/60′		a	60′/Δ		b	Δ/60′		a	60′/Δ		b	Δ/60′			1
	$d = 22° 30'$						$d = 23° 0'$						$d = 23° 30'$							

b / B	a = 24° 0′ h / d	60′/Δ	Z / t	Δ/60′	a = 24° 30′ h / d	60′/Δ	Z / t	Δ/60′	a = 25° 0′ h / d	60′/Δ	Z / t	Δ/60′	c / C	a / β
°	° ′		° ′		° ′		° ′		° ′		° ′		°	°
0	0 0	1.09	24 0	0.00	0 0	1.09	24 30	0.00	0 0	1.11	25 0	0.00	90	90.0
1	55	1.09	0	.02	55	1.11	30	.02	54	1.09	0	.02	89	89.6
2	1 50	1.11	1	.02	1 49	1.09	31	.02	1 49	1.11	1	.02	88	89.2
3	2 44	1.09	2	.02	2 44	1.11	32	.02	2 43	1.09	2	.02	87	88.8
4	3 39	1.09	3	.03	3 38	1.09	33	.03	3 38	1.11	3	.03	86	88.3
5	4 34	1.09	5	0.03	4 33	1.11	35	0.03	4 32	1.11	5	0.03	85	87.9
6	5 29	1.09	7	.05	5 27	1.09	37	.05	5 26	1.11	7	.05	84	87.5
7	6 24	1.11	10	.05	6 22	1.09	40	.05	6 20	1.09	10	.05	83	87.1
8	7 18	1.09	13	.05	7 17	1.11	43	.05	7 15	1.11	13	.05	82	86.7
9	8 13	1.09	16	.07	8 11	1.11	46	.07	8 9	1.11	16	.07	81	86.2
10	9 8	1.11	20	0.07	9 5	1.09	50	0.07	9 3	1.11	20	0.07	80	85.8
11	10 2	1.09	24	.07	10 0	1.11	54	.08	57	1.09	24	.08	79	85.4
12	57	1.09	28	.08	54	1.09	59	.08	10 52	1.11	29	.08	78	85.0
13	11 52	1.11	33	.10	11 49	1.11	25 4	.08	11 46	1.11	34	.10	77	84.5
14	12 46	1.09	39	.10	12 43	1.11	9	.10	12 40	1.11	40	.10	76	84.1
15	13 41	1.11	45	0.10	13 37	1.09	15	0.12	13 34	1.11	46	0.12	75	83.7
16	14 35	1.11	51	.12	14 32	1.11	22	.12	14 28	1.11	53	.12	74	83.2
17	15 29	1.09	58	.12	15 26	1.11	29	.12	15 22	1.11	26 0	.12	73	82.8
18	16 24	1.11	25 5	.13	16 20	1.11	36	.13	16 16	1.11	7	.13	72	82.3
19	17 18	1.11	13	.13	17 14	1.11	44	.13	17 10	1.13	15	.13	71	81.9
20	18 12	1.09	21	0.15	18 8	1.11	52	0.15	18 3	1.11	23	0.15	70	81.4
21	19 7	1.11	30	.15	19 2	1.11	26 1	.15	57	1.11	32	.17	69	81.0
22	20 1	1.11	39	.17	56	1.11	10	.17	19 51	1.13	42	.17	68	80.5
23	55	1.11	49	.17	20 50	1.13	20	.18	20 44	1.11	52	.18	67	80.0
24	21 49	1.11	59	.18	21 43	1.11	31	.18	21 38	1.13	27 3	.18	66	79.5
25	22 43	1.11	26 10	0.18	22 37	1.11	42	0.18	22 31	1.11	14	0.18	65	79.1
26	23 37	1.13	21	.20	23 31	1.13	53	.20	23 25	1.13	25	.20	64	78.6
27	24 30	1.11	33	.22	24 24	1.13	27 5	.22	24 18	1.13	37	.22	63	78.1
28	25 24	1.13	46	.22	25 17	1.11	18	.22	25 11	1.13	50	.23	62	77.6
29	26 17	1.11	59	.23	26 11	1.13	31	.23	26 4	1.13	28 4	.23	61	77.1
30	27 11	1.13	27 13	0.23	27 4	1.13	45	0.25	57	1.13	18	0.25	60	76.5
31	28 4	1.13	27	.25	57	1.13	28 0	.25	27 50	1.15	33	.25	59	76.0
32	57	1.13	42	.27	28 50	1.13	15	.27	28 42	1.13	48	.27	58	75.5
33	29 50	1.13	58	.27	29 43	1.15	31	.28	29 35	1.15	29 4	.28	57	74.9
34	30 43	1.13	28 14	.28	30 35	1.13	48	.28	30 27	1.15	21	.30	56	74.4
35	31 36	1.13	31	0.30	31 28	1.15	29 5	0.30	31 19	1.15	39	0.32	55	73.8
36	32 29	1.15	49	.32	32 20	1.15	23	.33	32 11	1.15	58	.32	54	73.2
37	33 21	1.15	29 8	.33	33 12	1.15	43	.33	33 3	1.15	30 17	.33	53	72.6
38	34 13	1.15	28	.35	34 4	1.15	30 3	.35	55	1.15	37	.35	52	72.0
39	35 5	1.15	49	.35	56	1.15	24	.35	34 47	1.18	58	.37	51	71.4
40	57	1.15	30 10	0.37	35 48	1.18	45	0.37	35 38	1.18	31 20	0.38	50	70.8
41	36 49	1.15	32	.40	36 39	1.18	31 7	.40	36 29	1.18	43	.40	49	70.2
42	37 41	1.18	56	.40	37 30	1.18	31	.42	37 20	1.18	32 7	.40	48	69.5
43	38 32	1.18	31 20	.42	38 21	1.18	56	.42	38 11	1.20	31	.43	47	68.9
44	39 23	1.18	45	.45	39 12	1.18	32 21	.45	39 1	1.20	57	.45	46	68.2
45	40 14		32 12		40 3		48		51		33 24		45	67.5

t	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′		a
	d = 24° 0′				d = 24° 30′				d = 25° 0′					

b / R	a = 24° 0′ h	d	60′/Δ	Z	t	Δ/60′	a = 24° 30′ h	d	60′/Δ	Z	t	Δ/60′	a = 25° 0′ h	d	60′/Δ	Z	t	Δ/60′	c / C	a / β
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
45	40 14		1.18	32 12		0.45	40 3		1.20	32 48		0.47	39 51		1.20	33 24		0.47	45	67.5
46	41 5		1.20		39	.48		53	1.20	33 16		.48	40 41		1.20		52	.50	44	66.8
47	55		1.20	33 8		.50	41 43		1.20		45	.50	41 31		1.22	34 22		.50	43	66.0
48	42 45		1.20		38	.53	42 33		1.22	34 15		.53	42 20		1.22		52	.53	42	65.3
49	43 35		1.20	34 10		.55	43 22		1.22		47	.55	43 9		1.22	35 24		.55	41	64.5
50	44 25		1.22		43	0.57	44 11		1.22	35 20		0.58		58	1.22		57	0.58	40	63.7
51	45 14		1.22	35 17		.60	45 0		1.22		55	.60	44 47		1.25	36 32		.60	39	62.9
52	46 3		1.25		53	.62		49	1.25	36 31		.62	45 35		1.28	37 8		.63	38	62.0
53	51		1.25	36 30		.65	46 37		1.25	37 8		.65	46 22		1.28		46	.67	37	61.2
54	47 39		1.25	37 9		.67	47 25		1.28		47	.68	47 9		1.28	38 26		.68	36	60.3
55	48 27		1.28		49	0.72	48 12		1.30	38 28		0.72		56	1.30	39 7		0.70	35	59.4
56	49 14		1.28	38 32		.73		58	1.30	39 11		.73	48 42		1.30		49	.75	34	58.4
57	50 1		1.30	39 16		.77	49 44		1.30		55	.78	49 28		1.30	40 34		.78	33	57.4
58	47		1.30	40 2		.80	50 30		1.33	40 42		.80	50 14		1.33	41 21		.80	32	56.4
59	51 33		1.33		50	.85	51 15		1.33	41 30		.85		59	1.36	42 9		.85	31	55.4
60	52 18		1.36	41 41		0.88	52 0		1.36	42 21		0.88	51 43		1.40	43 0		0.88	30	54.3
61	53 2		1.36	42 34		.92		44	1.40	43 14		.92	52 26		1.40		53	.92	29	53.2
62	46		1.40	43 29		.97	53 27		1.40	44 9		.97	53 9		1.43	44 48		.97	28	52.0
63	54 29		1.43	44 27		1.00	54 10		1.43	45 7		1.00	51		1.43	45 46		1.00	27	50.9
64	55 11		1.43	45 27		1.05		52	1.46	46 7		1.05	54 33		1.50	46 46		1.05	26	49.6
65	53		1.46	46 30		1.08	55 33		1.46	47 10		1.08	55 13		1.50	47 49		1.08	25	48.4
66	56 34		1.50	47 35		1.15	56 14		1.54	48 15		1.15	53		1.54	48 54		1.13	24	47.0
67	57 14		1.54	48 44		1.18		53	1.54	49 24		1.18	56 32		1.58	50 2		1.18	23	45.7
68	53		1.58	49 55		1.25	57 32		1.62	50 35		1.23	57 10		1.62	51 13		1.23	22	44.3
69	58 31		1.62	51 10		1.30	58 9		1.62	51 49		1.30		47	1.67	52 27		1.28	21	42.8
70	59 8		1.67	52 28		1.35		46	1.67	53 7		1.35	58 23		1.71	53 44		1.35	20	41.3
71	44		1.71	53 49		1.42	59 22		1.76	54 28		1.40		58	1.76	55 5		1.38	19	39.7
72	60 19		1.76	55 14		1.47		56	1.82	55 52		1.45	59 32		1.82	56 28		1.45	18	38.1
73	53		1.88	56 42		1.53	60 29		1.88	57 19		1.52	60 5		1.94	57 55		1.50	17	36.4
74	61 25		1.94	58 14		1.60	61 1		2.00	58 50		1.57		36	2.00	59 25		1.55	16	34.7
75	56		2.00	59 50		1.65		31	2.07	60 24		1.63	61 6		2.14	60 58		1.62	15	32.9
76	62 26		2.14	61 29		1.72	62 0		2.22	62 2		1.70		34	2.22	62 35		1.67	14	31.0
77	54		2.31	63 12		1.77		27	2.31	63 44		1.75	62 1		2.40	64 15		1.72	13	29.1
78	63 20		2.50	64 58		1.83		53	2.50	65 29		1.80		26	2.50	65 58		1.78	12	27.1
79	44		2.61	66 48		1.90	63 17		2.73	67 17		1.87		50	2.73	67 45		1.83	11	25.1
80	64 7		2.86	68 42		1.95		39	2.86	69 9		1.90	63 12		3.00	69 35		1.87	10	23.0
81	28		3.16	70 39		2.00	64 0		3.33	71 3		1.97		32	3.33	71 27		1.93	9	20.9
82	47		3.75	72 39		2.05		18	3.53	73 1		2.02		50	3.75	73 23		1.97	8	18.7
83	65 3		4.00	74 42		2.08		35	4.29	75 2		2.05	64 6		4.29	75 21		2.02	7	16.5
84	18		4.62	76 47		2.13		49	4.62	77 5		2.08		20	5.00	77 22		2.05	6	14.2
85	31		6.00	78 55		2.18	65 2		6.00	79 10		2.13		32	6.00	79 25		2.08	5	11.9
86	41		7.50	81 6		2.20		12	7.50	81 18		2.15		42	7.50	81 30		2.10	4	9.6
87	49		10.0	83 18		2.22		20	12.0	83 27		2.17		50	10.0	83 36		2.12	3	7.2
88	55		15.0	85 31		2.23		25	15.0	85 37		2.18		56	20.0	85 43		2.13	2	4.8
89	59		60.0	87 45		2.25		29	60.0	87 48		2.20		59	60.0	87 51		2.15	1	2.4
90	66 0			90 0				30		90 0			65 0			90 0			0	0.0
t	a	60′/Δ		b	Δ/60′		a	60′/Δ		b	Δ/60′		a	60′/Δ		b	Δ/60′			a
	d = 24° 0′						d = 24° 30′						d = 25° 0′							

b / B	a = 25° 30′ h / d	60′/Δ	Z / t	Δ/60′	a = 26° 0′ h / d	60′/Δ	Z / t	Δ/60′	a = 26° 30′ h / d	60′/Δ	Z / t	Δ/60′	c / C	a / β
°	° ′		° ′		° ′		° ′		° ′		° ′		°	°
0	0 0	1.11	25 30	0.00	0 0	1.11	26 0	0.00	0 0	1.11	26 30	0.00	90	90.0
1	54	1.11	30	.02	54	1.11	0	.02	54	1.13	30	.02	89	89.6
2	1 48	1.09	31	.02	1 48	1.11	1	.02	1 47	1.11	31	.02	88	89.1
3	2 43	1.11	32	.02	2 42	1.11	2	.02	2 41	1.11	32	.02	87	88.7
4	3 37	1.11	33	.03	3 36	1.11	3	.03	3 35	1.13	33	.03	86	88.2
5	4 31	1.11	35	0.03	4 30	1.13	5	0.03	4 28	1.11	35	0.03	85	87.8
6	5 25	1.11	37	.05	5 23	1.11	7	.05	5 22	1.11	37	.05	84	87.4
7	6 19	1.11	40	.05	6 17	1.11	10	.05	6 16	1.13	40	.05	83	86.9
8	7 13	1.11	43	.07	7 11	1.11	13	.07	7 9	1.11	43	.07	82	86.5
9	8 7	1.11	47	.07	8 5	1.11	17	.07	8 3	1.13	47	.07	81	86.1
10	9 1	1.11	51	0.07	59	1.11	21	0.07	56	1.11	51	0.08	80	85.6
11	55	1.11	55	.08	9 53	1.13	25	.08	9 50	1.13	56	.08	79	85.1
12	10 49	1.11	26 0	.08	10 46	1.11	30	.08	10 43	1.11	27 1	.08	78	84.7
13	11 43	1.11	5	.10	11 40	1.11	35	.10	11 37	1.13	6	.10	77	84.2
14	12 37	1.11	11	.10	12 34	1.13	41	.10	12 30	1.11	12	.10	76	83.8
15	13 31	1.13	17	0.12	13 27	1.11	47	0.12	13 24	1.13	18	0.12	75	83.3
16	14 24	1.11	24	.12	14 21	1.13	54	.12	14 17	1.13	25	.12	74	82.8
17	15 18	1.11	31	.12	15 14	1.11	27 1	.13	15 10	1.13	32	.13	73	82.4
18	16 12	1.13	38	.13	16 8	1.13	9	.13	16 3	1.13	40	.13	72	81.9
19	17 5	1.11	46	.15	17 1	1.13	17	.15	56	1.13	48	.15	71	81.4
20	59	1.13	55	0.15	54	1.13	26	0.15	17 49	1.13	57	0.15	70	80.9
21	18 52	1.11	27 4	.15	18 47	1.13	35	.17	18 42	1.13	28 6	.17	69	80.4
22	19 46	1.13	13	.17	19 40	1.13	45	.17	19 35	1.13	16	.17	68	80.0
23	20 39	1.13	23	.18	20 33	1.13	55	.18	20 28	1.13	26	.18	67	79.5
24	21 32	1.13	34	.18	21 26	1.13	28 6	.18	21 21	1.15	37	.20	66	79.0
25	22 25	1.13	45	0.20	22 19	1.13	17	0.20	22 13	1.13	49	0.20	65	78.4
26	23 18	1.13	57	.22	23 12	1.13	29	.22	23 6	1.15	29 1	.22	64	77.9
27	24 11	1.13	28 10	.22	24 5	1.15	42	.22	58	1.13	14	.22	63	77.4
28	25 4	1.13	23	.23	57	1.13	55	.23	24 51	1.15	27	.23	62	76.9
29	57	1.13	37	.23	25 50	1.15	29 9	.23	25 43	1.15	41	.25	61	76.3
30	26 50	1.15	51	c.25	26 42	1.15	23	0.25	26 35	1.15	56	0.25	60	75.8
31	27 42	1.13	29 6	.27	27 34	1.15	38	.27	27 27	1.15	30 11	.27	59	75.2
32	28 35	1.15	22	.27	28 26	1.15	54	.28	28 19	1.18	27	.28	58	74.7
33	29 27	1.15	38	.28	29 18	1.15	30 11	.28	29 10	1.15	44	.28	57	74.1
34	30 19	1.15	55	.30	30 10	1.15	28	.30	30 2	1.18	31 1	.32	56	73.5
35	31 11	1.15	30 13	0.30	31 2	1.18	46	0.32	53	1.18	20	0.32	55	72.9
36	32 3	1.18	31	.33	53	1.15	31 5	.33	31 44	1.18	39	.33	54	72.3
37	54	1.18	51	.33	32 45	1.18	25	33	32 35	1.18	59	.33	53	71.7
38	33 45	1.18	31 11	.35	33 36	1.18	45	.37	33 26	1.18	32 19	.37	52	71.1
39	34 36	1.18	32	.38	34 27	1.18	32 7	.37	34 17	1.20	41	.38	51	70.5
40	35 27	1.18	55	0.38	35 18	1.20	29	0.38	35 7	1.20	33 4	0.38	50	69.8
41	36 18	1.18	32 18	.40	36 8	1.20	52	.42	57	1.20	27	.40	49	69.1
42	37 9	1.18	42	.42	58	1.20	33 17	.42	36 47	1.20	51	.43	48	68.5
43	38 0	1.20	33 7	.43	37 48	1.20	42	.43	37 37	1.22	34 17	.45	47	67.8
44	50	1.20	33	.45	38 38	1.20	34 8	.47	38 26	1.22	44	.45	46	67.1
45	39 40		34 0		39 28		36		39 15		35 11		45	56.3
t	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′		a
	d = 25° 30′				d = 26° 0′				d = 26° 30′					

b	a = 25° 30′						a = 26° 0′						a = 26° 30′						c	a
B	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	C	β
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
45	39 40		1.22	34 0		0.47	39 28		1.22	34 36		0.47	39 15		1.22	35 11		0.48	45	66.3
46	40 29		1.22		28	.50	40 17		1.22	35 4		.50	40 4		1.22		40	.50	44	65.6
47	41 18		1.22		58	.52	41 6		1.22		34	.52		53	1.25	36 10		.52	43	64.8
48	42 7		1.22	35 29		.53		55	1.25	36 5		.53	41 41		1.25		41	.55	42	64.0
49		56	1.22	36 1		.57	42 43		1.25		37	.57	42 29		1.25	37 14		.57	41	63.2
50	43 45		1.25		35	0.58	43 31		1.28	37 11		0.58	43 17		1.28		48	0.58	40	62.4
51	44 33		1.28	37 10		.60	44 18		1.28		46	.62	44 4		1.28	38 23		.62	39	61.6
52	45 20		1.28		46	.63	45 5		1.28	38 23		.63		51	1.30	39 0		.63	38	60.7
53	46 7		1.28	38 24		.67		52	1.28	39 1		.67	45 37		1.30		38	.67	37	59.8
54		54	1.28	39 4		.68	46 39		1.30		41	.70	46 23		1.30	40 18		.70	36	58.9
55	47 41		1.30		45	0.72	47 25		1.33	40 23		0.72	47 9		1.33	41 0		0.72	35	58.0
56	48 27		1.33	40 28		.75	48 10		1.33	41 6		.75		54	1.36		43	.75	34	57.0
57	49 12		1.33	41 13		.77		55	1.33		51	.78	48 38		1.36	42 28		.78	33	56.0
58		57	1.36		59	.82	49 40		1.36	42 38		.80	49 22		1.36	43 15		.82	32	54.9
59	50 41		1.36	42 48		.85	50 24		1.40	43 26		.85	50 6		1.40	44 4		.85	31	53.9
60	51 25		1.40	43 39		0.88	51 7		1.43	44 17		0.88		49	1.43		55	0.88	30	52.8
61	52 8		1.43	44 32		.92		49	1.43	45 10		.93	51 31		1.46	45 48		.92	29	51.7
62		50	1.43	45 27		.97	52 31		1.43	46 6		.95	52 12		1.46	46 43		.97	28	50.5
63	53 32		1.46	46 25		1.00	53 13		1.50	47 3		1.00		53	1.50	47 41		1.00	27	49.3
64	54 13		1.50	47 25		1.05		53	1.50	48 3		1.03	53 33		1.54	48 41		1.03	26	48.1
65		53	1.50	48 28		1.08	54 33		1.54	49 5		1.08	54 12		1.58	49 43		1.08	25	46.8
66	55 33		1.58	49 33		1.13	55 12		1.58	50 10		1.13		50	1.58	50 48		1.12	24	45.4
67	56 11		1.58	50 41		1.17		50	1.62	51 18		1.17	55 28		1.67	51 55		1.17	23	44.1
68		49	1.67	51 51		1.23	56 27		1.67	52 28		1.23	56 4		1.67	53 5		1.22	22	42.7
69	57 25		1.67	53 5		1.27	57 3		1.71	53 42		1.27		40	1.71	54 18		1.25	21	41.2
70	58 1		1.76	54 21		1.33		38	1.76	54 58		1.32	57 15		1.82	55 33		1.30	20	39.7
71		35	1.82	55 41		1.38	58 12		1.88	56 17		1.37		48	1.88	56 51		1.37	19	38.1
72	59 8		1.88	57 4		1.43		44	1.88	57 39		1.42	58 20		1.94	58 13		1.40	18	36.5
73		40	1.94	58 30		1.48	59 16		2.00	59 4		1.47		51	2.00	59 37		1.45	17	34.9
74	60 11		2.07	59 59		1.53		46	2.07	60 32		1.52	59 21		2.14	61 4		1.50	16	33.2
75		40	2.14	61 31		1.58	60 15		2.22	62 3		1.57		49	2.22	62 34		1.55	15	31.4
76	61 8		2.22	63 6		1.65		42	2.31	63 37		1.62	60 16		2.40	64 7		1.60	14	29.6
77		35	2.50	64 45		1.70	61 8		2.50	65 14		1.68		41	2.50	65 43		1.65	13	27.8
78		59	2.61	66 27		1.75		32	2.61	66 55		1.72	61 5		2.61	67 22		1.70	12	25.9
79	62 22		2.73	68 12		1.80		55	2.86	68 38		1.77		28	3.00	69 4		1.73	11	23.9
80		44	3.00	70 0		1.85	62 16		3.16	70 24		1.82		48	3.16	70 48		1.78	10	21.9
81	63 4		3.53	71 51		1.88		35	3.33	72 13		1.85	62 7		3.53	72 35		1.82	9	19.9
82		21	3.75	73 44		1.93		53	4.00	74 4		1.90		24	4.00	74 24		1.87	8	17.8
83		37	4.29	75 40		1.97	63 8		4.29	75 58		1.93		39	4.29	76 16		1.90	7	15.6
84		51	5.00	77 38		2.02		22	5.45	77 54		1.97		53	5.45	78 10		1.92	6	13.5
85	64 3		6.00	79 39		2.03		33	6.00	79 52		2.00	63 4		6.67	80 5		1.95	5	11.3
86		13	8.57	81 41		2.05		43	8.57	81 52		2.02		13	8.57	82 2		1.97	4	9.1
87		20	10.0	83 44		2.08		50	10.0	83 53		2.03		20	10.0	84 0		2.00	3	6.8
88		26	20.0	85 49		2.08		56	20.0	85 55		2.03		26	20.0	86 0		2.00	2	4.6
89		29	60.0	87 54		2.10		59	60.0	87 57		2.05		29	60.0	88 0		2.00	1	2.3
90		30		90 0			64 0			90 0				30		90 0			0	0.0
t	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′		a
	d = 25° 30′						d = 26° 0′						d = 26° 30′							

b / B	a = 27° 0′						a = 27° 30′						a = 28° 0′						c / C	a / β
	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′		
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
0	0 0		1.13	27 0		0.00	0 0		1.13	27 30		0.00	0 0		1.13	28 0		0.00	90	90.0
1		53	1.11		0	.02		53	1.13		30	.02		53	1.13		0	.02	89	89.5
2	1 47		1.13		1	.02	1 46		1.11		31	.02	1 46		1.13		1	.02	88	89.1
3	2 40		1.11		2	.02	2 40		1.13		32	.02	2 39		1.13		2	.02	87	88.6
4	3 34		1.13		3	.03	3 33		1.13		33	.03	3 32		1.13		3	.03	86	88.2
5	4 27		1.11		5	0.05	4 26		1.13		35	0.05	4 25		1.13		5	0.05	85	87.7
6	5 21		1.13		8	.05	5 19		1.13		38	.05	5 18		1.13		8	.05	84	87.2
7	6 14		1.13		11	.05	6 12		1.13		41	.05	6 11		1.13		11	.05	83	86.8
8	7 7		1.11		14	.05	7 5		1.11		44	.07	7 4		1.15		14	.07	82	86.3
9	8 1		1.13		17	.07		59	1.13		48	.07		56	1.13		18	.07	81	85.8
10		54	1.13		21	0.08	8 52		1.13		52	0.07	8 49		1.13		22	0.08	80	85.3
11	9 47		1.11		26	.08	9 45		1.13		56	.08	9 42		1.13		27	.08	79	84.9
12	10 41		1.13		31	.08	10 38		1.13	28	1	.10	10 35		1.15		32	.08	78	84.4
13	11 34		1.13		36	.10	11 31		1.15		7	.10	11 27		1.13		37	.10	77	83.9
14	12 27		1.13		42	.12	12 23		1.13		13	.10	12 20		1.13		43	.12	76	83.4
15	13 20		1.13		49	0.12	13 16		1.13		19	0.12	13 13		1.15		50	0.12	75	82.9
16	14 13		1.13		56	.12	14 9		1.13		26	.13	14 5		1.13		57	.12	74	82.5
17	15 6		1.13	28	3	.13	15 2		1.13		34	.13		58	1.15	29	4	.13	73	82.0
18		59	1.13		11	.13		55	1.15		42	.13	15 50		1.15		12	.15	72	81.5
19	16 52		1.13		19	.15	16 47		1.13		50	.15	16 42		1.13		21	.15	71	81.0
20	17 45		1.15		28	0.15	17 40		1.15		59	0.17	17 35		1.15		30	0.17	70	80.5
21	18 37		1.13		37	.17	18 32		1.15	29	9	.17	18 27		1.15		40	.17	69	79.9
22	19 30		1.15		47	.18	19 24		1.13		19	.18	19 19		1.15		50	.18	68	79.4
23	20 22		1.13		58	.18	20 17		1.15		30	.18	20 11		1.15	30	1	.18	67	78.9
24	21 15		1.15	29	9	.20	21 9		1.15		41	.20	21 3		1.15		12	.20	66	78.4
25	22 7		1.13		21	0.20	22 1		1.15		53	0.20		55	1.18		24	0.22	65	77.8
26	23 0		1.15		33	.22		53	1.15	30	5	.22	22 46		1.15		37	.22	64	77.3
27		52	1.15		46	.22	23 45		1.15		18	.23	23 38		1.18		50	.22	63	76.8
28	24 44		1.15		59	.23	24 37		1.18		32	.23	24 29		1.15	31	3	.25	62	76.2
29	25 36		1.18	30	13	.25	25 28		1.15		46	.25	25 21		1.18		18	.25	61	75.6
30	26 27		1.15		28	0.27	26 20		1.18	31	1	0.25	26 12		1.18		33	0.27	60	75.1
31	27 19		1.15		44	.27	27 11		1.18		16	.28	27 3		1.18		49	.27	59	74.5
32	28 11		1.18	31	0	.28	28 2		1.18		33	.28		54	1.18	32	5	.28	58	73.9
33	29 2		1.18		17	.30		53	1.18		50	.30	28 45		1.20		22	.30	57	73.3
34		53	1.18		35	.30	29 44		1.18	32	8	.30	29 35		1.18		40	.32	56	72.7
35	30 44		1.18		53	0.32	30 35		1.18		26	0.33	30 26		1.20		59	0.33	55	72.1
36	31 35		1.18	32	12	.33	31 26		1.20		46	.33	31 16		1.20	33	19	.33	54	71.5
37	32 26		1.20		32	.35	32 16		1.20	33	6	.35	32 6		1.20		39	.37	53	70.8
38	33 16		1.20		53	.37	33 6		1.20		27	.37		56	1.20	34	1	.37	52	70.2
39	34 6		1.20	33	15	.38		56	1.20		49	.38	33 46		1.22		23	.38	51	69.5
40		56	1.20		38	0.38	34 46		1.22	34	12	0.40	34 35		1.22		46	0.40	50	68.8
41	35 46		1.20	34	1	.42	35 35		1.22		36	.42	35 24		1.22	35	10	.42	49	68.1
42	36 36		1.22		26	.43	36 24		1.22	35	1	.43	36 13		1.22		35	.43	48	67.4
43	37 25		1.22		52	.45	37 13		1.22		27	.45	37 2		1.25	36	1	.45	47	66.7
44	38 14		1.22	35	19	.47	38 2		1.22		54	.47		50	1.25		28	.48	46	66.0
45	39 3				47			51		36	22		38 38				57		45	65.2
t	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′		a
	d = 27° 0′						d = 27° 30′						d = 28° 0′							

b / B	a = 27° 0′				a = 27° 30′				a = 28° 0′				c / C	a / β
	h \ d	60′/Δ	Z \ t	Δ/60′	h \ d	60′/Δ	Z \ t	Δ/60′	h \ d	60′/Δ	Z \ t	Δ/60′		
°	° ′		° ′		° ′		° ′		° ′		° ′		°	°
45	39 3	1.22	35 47	0.48	38 51	1.25	36 22	0.48	38 38	1.25	36 57	0.48	45	65.2
46	52	1.25	36 16	.50	39 39	1.25	51	.50	39 26	1.28	37 26	.50	44	64.4
47	40 40	1.25	46	.52	40 27	1.28	37 21	.53	40 13	1.28	56	.53	43	63.7
48	41 28	1.28	37 17	.55	41 14	1.28	53	.55	41 0	1.28	38 28	.55	42	62.9
49	42 15	1.28	50	.57	42 1	1.28	38 26	.57	47	1.28	39 1	.58	41	62.0
50	43 2	1.28	38 24	0.60	48	1.28	39 0	0.60	42 34	1.30	36	0.60	40	61.2
51	49	1.28	39 0	.62	43 35	1.30	36	.62	43 20	1.33	40 12	.62	39	60.3
52	44 36	1.30	37	.63	44 21	1.33	40 13	.65	44 5	1.33	49	.65	38	59.4
53	45 22	1.33	40 15	.67	45 6	1.33	52	.67	50	1.33	41 28	.67	37	58.5
54	46 7	1.33	55	.70	51	1.33	41 32	.70	45 35	1.36	42 8	.70	36	57.6
55	52	1.33	41 37	0.72	46 36	1.36	42 14	0.72	46 19	1.36	50	0.73	35	56.6
56	47 37	1.36	42 20	.75	47 20	1.36	57	.75	47 3	1.40	43 34	.75	34	55.6
57	48 21	1.36	43 5	.78	48 4	1.40	43 42	.78	46	1.40	44 19	.78	33	54.6
58	49 5	1.40	52	.82	47	1.43	44 29	.82	48 29	1.43	45 6	.82	32	53.5
59	48	1.43	44 41	.85	49 29	1.43	45 18	.85	49 11	1.46	55	.85	31	52.5
60	50 30	1.43	45 32	0.88	50 11	1.46	46 9	0.88	52	1.46	46 46	0.87	30	51.3
61	51 12	1.46	46 25	.93	52	1.46	47 2	.92	50 33	1.50	47 38	.92	29	50.2
62	53	1.50	47 21	.95	51 33	1.50	57	.95	51 13	1.50	48 33	.95	28	49.0
63	52 33	1.50	48 18	1.00	52 13	1.54	48 54	1.00	53	1.58	49 30	1.00	27	47.8
64	53 13	1.58	49 18	1.03	52	1.58	49 54	1.03	52 31	1.58	50 30	1.02	26	46.6
65	51	1.58	50 20	1.07	53 30	1.58	50 56	1.07	53 9	1.62	51 31	1.07	25	45.3
66	54 29	1.62	51 24	1.12	54 8	1.67	52 0	1.12	46	1.67	52 35	1.10	24	44.0
67	55 6	1.67	52 31	1.17	44	1.67	53 7	1.15	54 22	1.71	53 41	1.15	23	42.6
68	42	1.71	53 41	1.20	55 20	1.76	54 16	1.18	57	1.76	54 50	1.18	22	41.2
69	56 17	1.76	54 53	1.25	54	1.76	55 27	1.25	55 31	1.82	56 1	1.23	21	39.7
70	51	1.82	56 8	1.28	56 28	1.88	56 42	1.28	56 4	1.88	57 15	1.27	20	38.2
71	57 24	1.88	57 25	1.35	57 0	1.94	57 59	1.32	36	1.94	58 31	1.32	19	36.7
72	56	2.00	58 46	1.38	31	2.00	59 18	1.38	57 7	2.07	59 50	1.37	18	35.1
73	58 26	2.07	60 9	1.43	58 1	2.07	60 41	1.42	36	2.14	61 12	1.40	17	33.5
74	55	2.14	61 35	1.48	30	2.22	62 6	1.47	58 4	2.22	62 36	1.45	16	31.8
75	59 23	2.22	63 4	1.53	57	2.31	63 34	1.52	31	2.31	64 3	1.48	15	30.1
76	50	2.40	64 36	1.58	59 23	2.40	65 5	1.55	57	2.50	65 32	1.53	14	28.4
77	60 15	2.61	66 11	1.62	48	2.61	66 38	1.60	59 21	2.61	67 4	1.58	13	26.6
78	38	2.73	67 48	1.67	60 11	2.86	68 14	1.63	44	2.86	68 39	1.62	12	24.7
79	61 0	3.00	69 28	1.72	32	3.00	69 52	1.68	60 5	3.16	70 16	1.65	11	22.8
80	20	3.16	71 11	1.75	52	3.33	71 33	1.72	24	3.33	71 55	1.68	10	20.9
81	39	3.53	72 56	1.78	61 10	3.53	73 16	1.77	42	3.75	73 36	1.73	9	18.9
82	56	4.29	74 43	1.83	27	4.29	75 2	1.80	58	4.29	75 20	1.77	8	16.9
83	62 10	4.62	76 33	1.85	41	4.62	76 50	1.82	61 12	4.62	77 6	1.78	7	14.9
84	23	5.00	78 24	1.90	54	5.45	78 39	1.85	25	5.45	78 53	1.82	6	12.8
85	35	6.67	80 18	1.90	62 5	6.67	80 30	1.87	36	7.50	80 42	1.83	5	10.7
86	44	8.57	82 12	1.93	14	8.57	82 22	1.90	44	8.57	82 32	1.85	4	8.6
87	51	12.0	84 8	1.95	21	12.0	84 16	1.90	51	12.0	84 23	1.87	3	6.5
88	56	20.0	86 5	1.95	26	20.0	86 10	1.92	56	20.0	86 15	1.87	2	4.3
89	59	60.0	88 2	1.97	29	60.0	88 5	1.92	59	60.0	88 7	1.88	1	2.2
90	63 0		90 0		30		90 0		62 0		90 0		0	0.0
t	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′		a
	d = 27° 0′				d = 27° 30′				d = 28° 0′					

b / B	a = 28° 30′						a = 29° 0′						a = 29° 30′						c / C	a / β
	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′		
°	°	′		°	′		°	′		°	′		°	′		°	′		°	°
0	0	0	1.13	28	30	0.00	0	0	1.15	29	0	0.00	0	0	1.15	29	30	0.00	90	90.0
1		53	1.13		30	.02		52	1.13		0	.02		52	1.15		30	.02	89	89.5
2	1	46	1.15		31	.02	1	45	1.15		1	.02	1	44	1.13		31	.02	88	89.0
3	2	38	1.13		32	.03	2	37	1.13		2	.03	2	37	1.15		32	.03	87	88.5
4	3	31	1.13		34	.03	3	30	1.15		4	.03	3	29	1.15		34	.03	86	88.1
5	4	24	1.15		36	0.03	4	22	1.13		6	0.03	4	21	1.15		36	0.03	85	87.6
6	5	16	1.13		38	.05	5	15	1.15		8	.05	5	13	1.15		38	.05	84	87.1
7	6	9	1.13		41	.05	6	7	1.15		11	.05	6	5	1.15		41	.05	83	86.6
8	7	2	1.15		44	.07		59	1.13		14	.07		57	1.15		44	.07	82	86.1
9		54	1.13		48	.07	7	52	1.15		18	.07	7	49	1.15		48	.08	81	85.6
10	8	47	1.15		52	0.08	8	44	1.15		22	0.08	8	41	1.15		53	0.08	80	85.1
11	9	39	1.13		57	.08	9	36	1.13		27	.08	9	33	1.15		58	.08	79	84.6
12	10	32	1.15	29	2	.10	10	29	1.15		32	.10	10	25	1.15	30	3	.10	78	84.1
13	11	24	1.13		8	.10	11	21	1.15		38	.10	11	17	1.15		9	.10	77	83.6
14	12	17	1.15		14	.12	12	13	1.15		44	.12	12	9	1.15		15	.12	76	83.1
15	13	9	1.15		21	0.12	13	5	1.15		51	0.12	13	1	1.15		22	0.12	75	82.6
16	14	1	1.15		28	.12		57	1.15		58	.13		53	1.15		29	.13	74	82.1
17		53	1.15		35	.13	14	49	1.15	30	6	.13	14	45	1.18		37	.13	73	81.6
18	15	45	1.15		43	.15	15	41	1.15		14	.15	15	36	1.15		45	.15	72	81.0
19	16	37	1.15		52	.15	16	33	1.18		23	.15	16	28	1.18		54	.15	71	80.5
20	17	29	1.15	30	1	0.17	17	24	1.15		32	0.17	17	19	1.15	31	3	0.17	70	80.0
21	18	21	1.15		11	.17	18	16	1.15		42	.17	18	11	1.18		13	.18	69	79.5
22	19	13	1.15		21	.18	19	8	1.18		52	.18	19	2	1.18		24	.18	68	78.9
23	20	5	1.15		32	.20		59	1.18	31	3	.20		53	1.18		35	.18	67	78.4
24		57	1.18		44	.20	20	50	1.18		15	.20	20	44	1.18		46	.20	66	77.8
25	21	48	1.15		56	0.20	21	41	1.18		27	0.22	21	35	1.18		58	0.22	65	77.3
26	22	40	1.18	31	8	.22	22	32	1.18		40	.22	22	26	1.20	32	11	.23	64	76.7
27	23	31	1.18		21	.23	23	23	1.18		53	.23	23	16	1.18		25	.23	63	76.1
28	24	22	1.18		35	.25	24	14	1.18	32	7	.25	24	7	1.20		39	.25	62	75.5
29	25	13	1.18		50	.25	25	5	1.18		22	.25		57	1.18		54	.27	61	75.0
30	26	4	1.18	32	5	0.27		56	1.18		37	0.27	25	48	1.20	33	10	0.27	60	74.4
31		55	1.20		21	.28	26	47	1.20		53	.28	26	38	1.20		26	.28	59	73.8
32	27	45	1.18		38	.28	27	37	1.20	33	10	.30	27	28	1.20		43	.28	58	73.1
33	28	36	1.20		55	.30	28	27	1.20		28	.30	28	18	1.22	34	0	.32	57	72.5
34	29	26	1.20	33	13	.32	29	17	1.20		46	.32	29	7	1.20		19	.32	56	71.9
35	30	16	1.20		32	0.33	30	7	1.22	34	5	0.33		57	1.22		38	0.33	55	71.3
36	31	6	1.20		52	.35		56	1.20		25	.35	30	46	1.22		58	.35	54	70.6
37		56	1.22	34	13	.35	31	46	1.22		46	.35	31	35	1.22	35	19	.37	53	69.9
38	32	45	1.22		34	.38	32	35	1.22	35	7	.38	32	24	1.22		41	.37	52	69.3
39	33	34	1.22		57	.38	33	24	1.22		30	.38	33	13	1.25	36	3	.40	51	68.6
40	34	23	1.22	35	20	0.40	34	13	1.25		53	0.42	34	1	1.25		27	0.40	50	67.9
41	35	12	1.22		44	.42	35	1	1.25	36	18	.42		49	1.25		51	.43	49	67.1
42	36	1	1.25	36	9	.45		49	1.25		43	.45	35	37	1.25	37	17	.45	48	66.4
43		49	1.25		36	.45	36	37	1.25	37	10	.45	36	25	1.28		44	.45	47	65.7
44	37	37	1.25	37	3	.47	37	25	1.28		37	.47	37	12	1.28	38	11	.48	46	64.9
45	38	25			31		38	12		38	5			59			40		45	64.1
t	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′		a
	d = 28° 30′						d = 29° 0′						d = 29° 30′							

b / B	$a = 28° 30'$						$a = 29° 0'$						$a = 29° 30'$						c / C	a / β
	d / h		60′/Δ	t / Z		Δ/60′	d / h		60′/Δ	t / Z		Δ/60′	d / h		60′/Δ	t / Z		Δ/60′		
°	°	′		°	′		°	′		°	′		°	′		°	′		°	°
45	38	25	1.25	37	31	0.50	38	12	1.28	38	5	0.50	37	59	1.28	38	40	0.50	45	64.1
46	39	13	1.28	38	1	.50		59	1.28		35	.52	38	46	1.30	39	10	.52	44	63.3
47	40	0	1.28		31	.53	39	46	1.30	39	6	.53	39	32	1.30		41	.53	43	62.5
48		47	1.30	39	3	.57	40	32	1.30		38	.55	40	18	1.30	40	13	.55	42	61.7
49	41	33	1.30		37	.57	41	18	1.30	40	11	.58	41	4	1.33		46	.58	41	60.9
50	42	19	1.30	40	11	0.60	42	4	1.33		46	0.60		49	1.33	41	21	0.60	40	60.0
51	43	5	1.33		47	.62		49	1.33	41	22	.63	42	34	1.36		57	.63	39	59.1
52		50	1.33	41	24	.65	43	34	1.36	42	0	.65	43	18	1.36	42	35	.65	38	58.2
53	44	35	1.36	42	3	.68	44	18	1.36		39	.67	44	2	1.36	43	14	.67	37	57.2
54	45	19	1.36		44	.70	45	2	1.36	43	19	.70		46	1.40		54	.70	36	56.3
55	46	3	1.40	43	26	0.72		46	1.40	44	1	0.73	45	29	1.43	44	36	0.73	35	55.3
56		46	1.40	44	9	.77	46	29	1.43		45	.75	46	11	1.43	45	20	.75	34	54.3
57	47	29	1.43		55	.78	47	11	1.43	45	30	.78		53	1.46	46	5	.78	33	53.3
58	48	11	1.43	45	42	.82		53	1.46	46	17	.82	47	34	1.46		52	.82	32	52.2
59		53	1.46	46	31	.85	48	34	1.50	47	6	.85	48	15	1.50	47	41	.85	31	51.1
60	49	34	1.50	47	22	0.87	49	14	1.50		57	0.88		55	1.54	48	32	0.88	30	50.0
61	50	14	1.54	48	14	.92		54	1.54	48	50	.90	49	34	1.54	49	25	.90	29	48.8
62		53	1.54	49	9	.95	50	33	1.54	49	44	.95	50	13	1.58	50	19	.93	28	47.6
63	51	32	1.58	50	6	.98	51	12	1.62	50	41	.98		51	1.62	51	15	.98	27	46.4
64	52	10	1.58	51	5	1.02		49	1.62	51	40	1.02	51	28	1.67	52	14	1.00	26	45.2
65		48	1.67	52	6	1.07	52	26	1.67	52	41	1.05	52	4	1.67	53	14	1.05	25	43.9
66	53	24	1.71	53	10	1.10	53	2	1.71	53	44	1.08		40	1.76	54	17	1.08	24	42.6
67		59	1.71	54	16	1.13		37	1.76	54	49	1.13	53	14	1.76	55	22	1.12	23	41.2
68	54	34	1.76	55	24	1.18	54	11	1.82	55	57	1.17		48	1.82	56	29	1.17	22	39.8
69	55	8	1.88	56	35	1.22		44	1.88	57	7	1.20	54	21	1.94	57	39	1.20	21	38.4
70		40	1.88	57	48	1.25	55	16	1.94	58	19	1.25		52	1.94	58	51	1.23	20	36.9
71	56	12	2.00	59	3	1.30		47	2.00	59	34	1.30	55	23	2.07	60	5	1.27	19	35.4
72		42	2.07	60	21	1.35	56	17	2.07	60	52	1.33		52	2.14	61	21	1.32	18	33.8
73	57	11	2.14	61	42	1.38		46	2.22	62	12	1.37	56	20	2.22	62	40	1.37	17	32.2
74		39	2.31	63	5	1.43	57	13	2.31	63	34	1.40		47	2.31	64	2	1.38	16	30.6
75	58	5	2.40	64	31	1.47		39	2.40	64	58	1.45	57	13	2.50	65	25	1.43	15	28.9
76		30	2.50	65	59	1.50	58	4	2.61	66	25	1.48		37	2.61	66	51	1.47	14	27.2
77		54	2.73	67	29	1.55		27	2.73	67	54	1.53	58	0	2.86	68	19	1.50	13	25.5
78	59	16	2.86	69	2	1.60		49	3.00	69	26	1.57		21	3.00	69	49	1.55	12	23.7
79		37	3.16	70	38	1.63	59	9	3.16	71	0	1.60		41	3.16	71	22	1.57	11	21.8
80		56	3.33	72	16	1.67		28	3.53	72	36	1.63	59	0	3.53	72	56	1.62	10	20.0
81	60	14	4.00	73	56	1.68		45	4.00	74	14	1.67		17	4.00	74	33	1.63	9	18.1
82		29	4.29	75	37	1.73	60	0	4.29	75	54	1.70		32	4.62	76	11	1.67	8	16.2
83		43	4.62	77	21	1.75		14	5.00	77	36	1.72		45	5.00	77	51	1.68	7	14.2
84		56	6.00	79	6	1.78		26	6.00	79	19	1.75		57	6.00	79	32	1.70	6	12.2
85	61	6	6.67	80	53	1.80		36	6.67	81	4	1.77	60	7	7.50	81	14	1.73	5	10.2
86		15	10.0	82	41	1.82		45	10.0	82	50	1.77		15	8.57	82	58	1.75	4	8.2
87		21	12.0	84	30	1.82		51	12.0	84	36	1.80		22	15.0	84	43	1.75	3	6.2
88		26	20.0	86	19	1.83		56	20.0	86	24	1.80		26	20.0	86	28	1.77	2	4.1
89		29	60.0	88	9	1.85		59	60.0	88	12	1.80		29	60.0	88	14	1.77	1	2.1
90		30		90	0		61	0		90	0			30		90	0		0	0.0
t	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′		a
	$d = 28° 30'$						$d = 29° 0'$						$d = 29° 30'$							

b / B	a = 30° 0′						a = 30° 30′						a = 31° 0′						c	β
	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	C	
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
0	0 0		1.15	30 0		0.00	0 0		1.15	30 30		0.00	0 0		1.18	31 0		0.00	90	90.0
1		52	1.15		0	.02		52	1.18		30	.02		51	1.15		0	.02	89	89.5
2	1 44		1.15		1	.02	1 43		1.15		31	.02	1 43		1.18		1	.02	88	89.0
3	2 36		1.15		2	.03	2 35		1.15		32	.03	2 34		1.15		2	.03	87	88.5
4	3 28		1.15		4	.03	3 27		1.18		34	.03	3 26		1.18		4	.03	86	88.0
5	4 20		1.15		6	0.03	4 18		1.15		36	0.03	4 17		1.18		6	0.03	85	87.5
6	5 12		1.15		8	.05	5 10		1.15		38	.05	5 8		1.15		8	.05	84	86.9
7	6 4		1.18		11	.07	6 2		1.18		41	.07	6 0		1.18		11	.07	83	86.4
8		55	1.15		15	.07		53	1.15		45	.07		51	1.15		15	.07	82	85.9
9	7 47		1.15		19	.07	7 45		1.18		49	.07	7 43		1.18		19	.07	81	85.4
10	8 39		1.15		23	0.08	8 36		1.15		53	0.08	8 34		1.18		23	0.08	80	84.9
11	9 31		1.18		28	.08	9 28		1.18		58	.08	9 25		1.18		28	.10	79	84.4
12	10 22		1.15		33	.10	10 19		1.15	31	3	.10	10 16		1.18		34	.10	78	83.8
13	11 14		1.15		39	.10	11 11		1.18		9	.12	11 7		1.18		40	.10	77	83.3
14	12 6		1.18		45	.12	12 2		1.18		16	.12		58	1.18		46	.12	76	82.8
15		57	1.15		52	0.12		53	1.18		23	0.12	12 49		1.18		53	0.13	75	82.3
16	13 49		1.18		59	.13	13 44		1.18		30	.13	13 40		1.18	32	1	.13	74	81.7
17	14 40		1.18	31	7	.15	14 35		1.18		38	.13	14 31		1.18		9	.13	73	81.2
18	15 31		1.15		16	.15	15 26		1.18		46	.15	15 22		1.20		17	.15	72	80.6
19	16 23		1.18		25	.15	16 17		1.18		55	.17	16 12		1.18		26	.17	71	80.1
20	17 14		1.18		34	0.17	17 8		1.18	32	5	0.17	17 3		1.20		36	0.17	70	79.5
21	18 5		1.18		44	.18		59	1.18		15	.18		53	1.18		46	.18	69	79.0
22		56	1.18		55	.18	18 50		1.18		26	.18	18 44		1.20		57	.18	68	78.4
23	19 47		1.20	32	6	.20	19 41		1.20		37	.20	19 34		1.20	33	8	.20	67	77.8
24	20 37		1.18		18	.20	20 31		1.20		49	.20	20 24		1.20		20	.22	66	77.3
25	21 28		1.18		30	0.22	21 21		1.20	33	1	0.22	21 14		1.20		33	0.22	65	76.7
26	22 19		1.20		43	.23	22 11		1.20		14	.23	22 4		1.20		46	.23	64	76.1
27	23 9		1.20		57	.23	23 1		1.20		28	.23		54	1.20	34	0	.23	63	75.5
28		59	1.20	33	11	.25		51	1.20		42	.25	23 44		1.22		14	.25	62	74.9
29	24 49		1.20		26	.25	24 41		1.20		57	.27	24 33		1.20		29	.27	61	74.3
30	25 39		1.20		41	0.28	25 31		1.20	34	13	0.28	25 23		1.22		45	0.28	60	73.7
31	26 29		1.20		58	.28	26 21		1.22		30	.28	26 12		1.22	35	2	.28	59	73.0
32	27 19		1.20	34	15	.30	27 10		1.22		47	.30	27 1		1.22		19	.30	58	72.4
33	28 9		1.22		33	.30		59	1.22	35	5	.32		50	1.22		37	.32	57	71.8
34		58	1.22		51	.33	28 48		1.22		24	.32	28 39		1.25		56	.33	56	71.1
35	29 47		1.22	35	11	0.33	29 37		1.22		43	0.35	29 27		1.25	36	16	0.33	55	70.4
36	30 36		1.22		31	.35	30 26		1.25	36	4	.35	30 15		1.25		36	.35	54	69.8
37	31 25		1.25		52	.37	31 14		1.25		25	.37	31 3		1.25		57	.38	53	69.1
38	32 13		1.25	36	14	.38	32 2		1.25		47	.38		51	1.25	37	20	.38	52	68.4
39	33 1		1.25		37	.38		50	1.25	37	10	.40	32 39		1.28		43	.40	51	67.7
40		49	1.25	37	0	0.42	33 38		1.28		34	0.40	33 26		1.28	38	7	0.40	50	66.9
41	34 37		1.25		25	.43	34 25		1.28		58	.43	34 13		1.28		31	.43	49	66.2
42	35 25		1.28		51	.43	35 12		1.28	38	24	.45	35 0		1.30		57	.45	48	65.4
43	36 12		1.28	38	17	.47		59	1.28		51	.47		46	1.28	39	24	.47	47	64.7
44		59	1.28		45	.48	36 46		1.30	39	19	.48	36 33		1.30		52	.48	46	63.9
45	37 46			39	14		37 32				48		37 19			40	21		45	63.1
t	a	60′/Δ	b	Δ/60′			a	60′/Δ	b	Δ/60′			a	60′/Δ	b	Δ/60′				a
	d = 30° 0′						d = 30° 30′						d = 31° 0′							

b / B	a = 30° 0′						a = 30° 30′						a = 31° 0′						c / C	a / β
	d		60′/Δ	t		Δ/60′	d		60′/Δ	t		Δ/60′	d		60′/Δ	t		Δ/60′		
	h			Z			h			Z			h			Z				
°	°	′		°	′		°	′		°	′		°	′		°	′		°	°
45	37	46	1.30	39	14	0.50	37	32	1.30	39	48	0.50	37	19	1.33	40	21	0.52	45	63.1
46	38	32	1.30		44	.52	38	18	1.30	40	18	.52	38	4	1.33		52	.52	44	62.3
47	39	18	1.30	40	15	.53	39	4	1.33		49	.53		49	1.33	41	23	.53	43	61.4
48	40	4	1.33		47	.57		49	1.33	41	21	.57	39	34	1.33		55	.57	42	60.6
49		49	1.33	41	21	.58	40	34	1.36		55	.58	40	19	1.36	42	29	.58	41	59.7
50	41	34	1.36		56	0.60	41	18	1.36	42	30	0.60	41	3	1.40	43	4	0.60	40	58.8
51	42	18	1.36	42	32	.63	42	2	1.36	43	6	.63		46	1.40		40	.63	39	57.9
52	43	2	1.36	43	10	.65		46	1.40		44	.65	42	29	1.40	44	18	.65	38	57.0
53		46	1.40		49	.67	43	29	1.40	44	23	.68	43	12	1.43		57	.68	37	56.0
54	44	29	1.43	44	29	.70	44	12	1.43	45	4	.70		54	1.43	45	38	.70	36	55.1
55	45	11	1.43	45	11	0.73		54	1.46		46	0.73	44	36	1.46	46	20	0.73	35	54.1
56		53	1.43		55	.75	45	35	1.46	46	30	.75	45	17	1.46	47	4	.75	34	53.0
57	46	35	1.46	46	40	.78	46	16	1.46	47	15	.78		58	1.50		49	.77	33	52.0
58	47	16	1.50	47	27	.82		57	1.50	48	2	.80	46	38	1.54	48	35	.82	32	50.9
59		56	1.50	48	16	.83	47	37	1.54		50	.83	47	17	1.54	49	24	.83	31	49.8
60	48	36	1.54	49	6	0.88	48	16	1.58	49	40	0.88		56	1.58	50	14	0.87	30	48.7
61	49	15	1.58		59	.90		54	1.58	50	33	.90	48	34	1.62	51	6	.90	29	47.5
62		53	1.62	50	53	.93	49	32	1.62	51	27	.93	49	11	1.62	52	0	.93	28	46.3
63	50	30	1.62	51	49	.98	50	9	1.67	52	23	.97		48	1.67		56	.95	27	45.1
64	51	7	1.67	52	48	1.00		45	1.71	53	21	1.00	50	24	1.71	53	53	1.00	26	43.9
65		43	1.71	53	48	1.03	51	20	1.71	54	21	1.03		59	1.76	54	53	1.03	25	42.6
66	52	18	1.76	54	50	1.08		55	1.76	55	23	1.07	51	33	1.82	55	55	1.05	24	41.3
67		52	1.82	55	55	1.10	52	29	1.88	56	27	1.10	52	6	1.88	56	58	1.08	23	39.9
68	53	25	1.88	57	1	1.15	53	1	1.88	57	33	1.13		38	1.94	58	3	1.13	22	38.5
69		57	1.94	58	10	1.18		33	1.94	58	41	1.18	53	9	2.00	59	11	1.17	21	37.1
70	54	28	2.00	59	21	1.23	54	4	2.07	59	52	1.20		39	2.07	60	21	1.20	20	35.6
71		58	2.07	60	35	1.27		33	2.07	61	4	1.25	54	8	2.14	61	33	1.23	19	34.2
72	55	27	2.14	61	51	1.30	55	2	2.22	62	19	1.28		36	2.22	62	47	1.27	18	32.6
73		55	2.31	63	9	1.33		29	2.31	63	36	1.32	55	3	2.31	64	3	1.30	17	31.1
74	56	21	2.40	64	29	1.37		55	2.40	64	55	1.37		29	2.50	65	21	1.35	16	29.5
75		46	2.50	65	51	1.42	56	20	2.61	66	17	1.38		53	2.61	66	42	1.37	15	27.8
76	57	10	2.61	67	16	1.45		43	2.73	67	40	1.43	56	16	2.73	68	4	1.42	14	26.2
77		33	2.86	68	43	1.48	57	5	2.86	69	6	1.45		38	3.00	69	29	1.43	13	24.5
78		54	3.16	70	12	1.52		26	3.16	70	33	1.50		58	3.16	70	55	1.47	12	22.7
79	58	13	3.33	71	43	1.55		45	3.33	72	3	1.52	57	17	3.33	72	23	1.50	11	21.0
80		31	3.53	73	16	1.57	58	3	3.75	73	34	1.55		35	3.75	73	53	1.52	10	19.2
81		48	4.00	74	50	1.62		19	4.00	75	7	1.58		51	4.29	75	24	1.55	9	17.3
82	59	3	4.62	76	27	1.63		34	4.62	76	42	1.60	58	5	4.62	76	57	1.58	8	15.5
83		16	5.00	78	5	1.65		47	5.45	78	18	1.63		18	5.45	78	32	1.60	7	13.6
84		28	6.00	79	44	1.68		58	6.00	79	56	1.65		29	6.67	80	8	1.62	6	11.7
85		38	7.50	81	25	1.70	59	8	7.50	81	35	1.67		38	7.50	81	45	1.63	5	9.8
86		46	10.0	83	7	1.70		16	10.0	83	15	1.67		46	10.0	83	23	1.63	4	7.8
87		52	15.0	84	49	1.72		22	15.0	84	55	1.68		52	15.0	85	1	1.65	3	5.9
88		56	20.0	86	32	1.73		26	20.0	86	36	1.70		56	20.0	86	40	1.67	2	3.9
89		59	60.0	88	16	1.73		29	60.0	88	18	1.70		59	60.0	88	20	1.67	1	2.0
90	60	0		90	0			30		90	0		59	0		90	0		0	0.0
t	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′		a
	d = 30° 0′						d = 30° 30′						d = 31° 0′							

b / B	a = 31° 30′						a = 32° 0′						a = 32° 30′						c / C	a / β
	h \ d	60′/Δ		Z \ t	Δ/60′		h \ d	60′/Δ		Z \ t	Δ/60′		k \ d	60′/Δ		Z \ t	Δ/60′			
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
0	0 0	1.18		31 30	0.00		0 0	1.18		32 0	0.00		0 0	1.18		32 30	0.00		90	90.0
1	51	1.18		30	.02		51	1.18		0	.02		51	1.20		30	.02		89	89.5
2	1 42	1.15		31	.02		1 42	1.18		1	.02		1 41	1.18		31	.02		88	88.9
3	2 34	1.18		32	.03		2 33	1.20		2	.03		2 32	1.20		32	.03		87	88.4
4	3 25	1.18		34	.03		3 23	1.18		4	.03		3 22	1.18		34	.03		86	87.9
5	4 16	1.18		36	0.03		4 14	1.18		6	0.03		4 13	1.20		36	0.05		85	87.3
6	5 7	1.18		38	.05		5 5	1.18		8	.05		5 3	1.18		39	.05		84	86.8
7	58	1.18		41	.07		56	1.18		11	.07		54	1.20		42	.05		83	86.3
8	6 49	1.18		45	.07		6 47	1.20		15	.07		6 44	1.18		45	.07		82	85.7
9	7 40	1.18		49	.08		7 37	1.18		19	.08		7 35	1.20		49	.08		81	85.2
10	8 31	1.18		54	0.08		8 28	1.18		24	0.08		8 25	1.18		54	0.08		80	84.7
11	9 22	1.18		59	.08		9 19	1.20		29	.08		9 16	1.20		59	.10		79	84.1
12	10 13	1.18		32 4	.10		10 9	1.18		34	.10		10 6	1.20		33 5	.10		78	83.6
13	11 4	1.20		10	.12		11 0	1.20		40	.12		56	1.20		11	.10		77	83.0
14	54	1.18		17	.12		50	1.18		47	.12		11 46	1.20		17	.12		76	82.5
15	12 45	1.18		24	0.12		12 41	1.20		54	0.13		12 36	1.20		24	0.13		75	81.9
16	13 36	1.20		31	.13		13 31	1.20		33 2	.13		13 26	1.20		32	.13		74	81.4
17	14 26	1.18		39	.15		14 21	1.18		10	.13		14 16	1.20		40	.15		73	80.8
18	15 17	1.20		48	.15		15 12	1.20		18	.15		15 6	1.20		49	.15		72	80.2
19	16 7	1.20		57	.17		16 2	1.20		27	.17		56	1.20		58	.17		71	79.7
20	57	1.20		33 7	0.17		52	1.20		37	0.18		16 46	1.20		34 8	0.18		70	79.1
21	17 47	1.20		17	.18		17 42	1.22		48	.18		17 36	1.22		19	.18		69	78.5
22	18 37	1.20		28	.18		18 31	1.20		59	.18		18 25	1.22		30	.18		68	77.9
23	19 27	1.20		39	.20		19 21	1.20		34 10	.20		19 14	1.20		41	.20		67	77.3
24	20 17	1.20		51	.22		20 11	1.22		22	.22		20 4	1.22		53	.22		66	76.7
25	21 7	1.20		34 4	0.22		21 0	1.22		35	0.22		53	1.22		35 6	0.23		65	76.1
26	57	1.20		17	.23		49	1.22		48	.23		21 42	1.22		20	.23		64	75.5
27	22 47	1.22		31	.25		22 38	1.22		35 2	.25		22 31	1.22		34	.25		63	74.9
28	23 36	1.22		46	.25		23 27	1.22		19	.27		23 20	1.25		49	.25		62	74.3
29	24 25	1.22		35 1	.27		24 16	1.22		33	.27		24 8	1.22		36 4	.27		61	73.6
30	25 14	1.22		17	0.28		25 5	1.22		49	0.28		57	1.25		20	0.28		60	73.0
31	26 3	1.22		34	.28		54	1.25		36 6	.28		25 45	1.25		37	.30		59	72.3
32	52	1.25		51	.30		26 42	1.25		23	.30		26 33	1.25		55	.30		58	71.7
33	27 40	1.22		36 9	.32		27 30	1.25		41	.32		27 21	1.28		37 13	.32		57	71.0
34	28 29	1.25		28	.33		28 18	1.25		37 0	.33		28 8	1.25		32	.33		56	70.3
35	29 17	1.25		48	0.35		29 6	1.25		20	0.35		56	1.28		52	0.35		55	69.6
36	30 5	1.25		37 9	.35		54	1.28		41	.35		29 43	1.28		38 13	.37		54	68.9
37	53	1.28		30	.37		30 41	1.28		38 2	.38		30 30	1.28		35	.37		53	68.2
38	31 40	1.28		52	.38		31 28	1.28		25	.38		31 17	1.28		57	.40		52	67.5
39	32 27	1.28		38 15	.40		32 15	1.28		48	.40		32 4	1.30		39 21	.40		51	66.8
40	33 14	1.28		39	0.43		33 2	1.30		39 12	0.42		50	1.30		45	0.42		50	66.0
41	34 1	1.30		39 5	.43		48	1.30		37	.45		33 36	1.30		40 10	.43		49	65.3
42	47	1.30		31	.45		34 34	1.30		40 4	.45		34 22	1.33		36	.47		48	64.5
43	35 33	1.30		58	.47		35 20	1.30		31	.47		35 7	1.33		41 4	.47		47	63.7
44	36 19	1.30		40 26	.48		36 6	1.33		59	.48		52	1.33		32	.48		46	62.9
45	37 5			55			51			41 28			36 37			42 1			45	62.1
t	a	60′/Δ		b	Δ/60′		a	60′/Δ		b	Δ/60′		a	60′/Δ		b	Δ/60′			a
	d = 31° 30′						d = 32° 0′						d = 32° 30′							

b / B	a = 31° 30′						a = 32° 0′						a = 32° 30′						c / C	a / β
	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′		
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
45	37 5		1.33	40 55		0.50	36 51		1.33	41 28		0.50	36 37		1.36	42 1		0.50	45	62.1
46	50		1.33	41 25		.52	37 36		1.36	58		.53	37 21		1.36	31		.53	44	61.2
47	38 35		1.36	56		.55	38 20		1.36	42 30		.53	38 5		1.36	43 3		.55	43	60.4
48	39 19		1.36	42 29		.57	39 4		1.36	43 2		.57	49		1.40	36		.57	42	59.5
49	40 3		1.36	43 3		.58	48		1.40	36		.58	39 32		1.40	44 10		.58	41	58.6
50	47		1.40	38		0.60	40 31		1.40	44 11		0.62	40 15		1.43	45		0.60	40	57.7
51	41 30		1.40	44 14		.63	41 14		1.43	48		.63	57		1.43	45 21		.63	39	56.8
52	42 13		1.43	52		.65	56		1.43	45 26		.65	41 39		1.43	59		.65	38	55.9
53	55		1.43	45 31		.68	42 38		1.46	46 5		.67	42 21		1.46	46 38		.67	37	54.9
54	43 37		1.46	46 12		.70	43 19		1.46	45		.70	43 2		1.50	47 18		.70	36	53.9
55	44 18		1.46	54		0.72	44 0		1.50	47 27		0.72	42		1.50	48 0		0.72	35	52.9
56	59		1.50	47 37		.75	40		1.50	48 10		.75	44 22		1.54	43		.75	34	51.8
57	45 39		1.50	48 22		.78	45 20		1.54	55		.78	45 1		1.54	49 28		.78	33	50.8
58	46 19		1.54	49 9		.80	59		1.54	49 42		.80	40		1.58	50 15		.80	32	49.7
59	58		1.58	57		.83	46 38		1.58	50 30		.83	46 18		1.62	51 3		.83	31	48.6
60	47 36		1.62	50 47		0.87	47 16		1.62	51 20		0.87	55		1.62	53		0.85	30	47.5
61	48 13		1.62	51 39		.90	53		1.67	52 12		.88	47 32		1.67	52 44		.88	29	46.3
62	50		1.67	52 33		.92	48 29		1.67	53 5		.92	48 8		1.71	53 37		.92	28	45.1
63	49 26		1.71	53 28		.95	49 5		1.71	54 0		.95	43		1.76	54 32		.93	27	43.9
64	50 1		1.71	54 25		.98	40		1.76	57		.98	49 17		1.76	55 28		.97	26	42.6
65	36		1.76	55 24		1.03	50 14		1.82	55 56		1.00	51		1.82	56 26		1.02	25	41.3
66	51 10		1.88	56 26		1.05	47		1.88	56 56		1.05	50 24		1.88	57 27		1.03	24	40.0
67	42		1.88	57 29		1.08	51 19		1.94	57 59		1.08	56		1.94	58 29		1.07	23	38.7
68	52 14		1.94	58 34		1.12	50		1.94	59 4		1.10	51 27		2.07	59 33		1.10	22	37.3
69	45		2.00	59 41		1.15	52 21		2.07	60 10		1.13	56		2.07	60 39		1.12	21	35.9
70	53 15		2.07	60 50		1.18	50		2.14	61 18		1.18	52 25		2.14	61 46		1.17	20	34.5
71	44		2.22	62 1		1.22	53 18		2.22	62 29		1.20	53		2.22	62 56		1.20	19	33.0
72	54 11		2.22	63 14		1.27	45		2.31	63 41		1.25	53 20		2.31	64 8		1.22	18	31.5
73	38		2.40	64 30		1.28	54 11		2.40	64 56		1.27	46		2.50	65 21		1.25	17	30.0
74	55 3		2.50	65 47		1.32	36		2.50	66 12		1.30	54 10		2.61	66 36		1.28	16	28.4
75	27		2.61	67 6		1.35	55 0		2.73	67 30		1.33	33		2.73	67 53		1.32	15	26.8
76	50		2.86	68 27		1.38	22		2.86	68 50		1.37	55		2.86	69 12		1.35	14	25.2
77	56 11		3.00	69 50		1.42	43		3.00	70 12		1.40	55 16		3.16	70 33		1.38	13	23.5
78	31		3.33	71 15		1.45	56 3		3.33	71 36		1.42	35		3.33	71 56		1.40	12	21.9
79	49		3.53	72 42		1.48	21		3.53	73 1		1.45	53		3.53	73 20		1.42	11	20.1
80	57 6		3.75	74 11		1.50	38		4.00	74 28		1.48	56 10		4.00	74 45		1.45	10	18.4
81	22		4.29	75 41		1.52	53		4.29	75 57		1.50	25		4.62	76 12		1.48	9	16.6
82	36		4.62	77 12		1.55	57 7		5.00	77 27		1.52	38		5.00	77 41		1.48	8	14.9
83	49		5.45	78 45		1.57	19		5.45	78 58		1.53	50		5.45	79 10		1.52	7	13.0
84	58 0		6.67	80 19		1.58	30		6.67	80 30		1.57	57 1		6.67	80 41		1.53	6	11.2
85	9		8.57	81 54		1.60	39		7.50	82 4		1.57	10		8.57	82 13		1.53	5	9.4
86	16		10.0	83 30		1.62	47		10.0	83 38		1.58	17		10.0	83 45		1.55	4	7.5
87	22		12.0	85 7		1.62	53		15.0	85 13		1.58	23		15.0	85 18		1.57	3	5.6
88	27		30.0	86 44		1.63	57		30.0	86 48		1.60	27		30.0	86 52		1.57	2	3.8
89	29		60.0	88 22		1.63	59		60.0	88 24		1.60	29		60.0	88 26		1.57	1	1.9
90	30			90 0			58 0			90 0			30			90 0			0	0.0
t	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′		α
	d = 31° 30′						d = 32° 0′						d = 32° 30′							

b / B	a = 33° 0′						a = 33° 30′						a = 34° 0′						c / C	a / β
	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′		
°	°	′		°	′		°	′		°	′		°	′		°	′		°	°
0	0	0	1.20	33	0	0.00	0	0	1.20	33	30	0.00	0	0	1.20	34	0	0.00	90	90.0
1		50	1.18		0	.02		50	1.20		30	.02		50	1.22		0	.02	89	89.4
2	1	41	1.20		1	.02	1	40	1.20		31	.02	1	39	1.20		1	.02	88	88.9
3	2	31	1.20		2	.03	2	30	1.20		32	.03	2	29	1.20		2	.03	87	88.3
4	3	21	1.18		4	.03	3	20	1.20		34	.03	3	19	1.20		4	.03	86	87.8
5	4	12	1.20		6	0.05	4	10	1.20		36	0.05	4	9	1.22		6	0.05	85	87.2
6	5	2	1.20		9	.05	5	0	1.20		39	.05		58	1.20		9	.05	84	86.7
7		52	1.20		12	.05		50	1.20		42	.07	5	48	1.20		12	.07	83	86.1
8	6	42	1.20		15	.07	6	40	1.20		46	.07	6	38	1.22		16	.07	82	85.6
9	7	32	1.20		19	.08	7	30	1.20		50	.07	7	27	1.20		20	.08	81	85.0
10	8	22	1.20		24	0.08	8	20	1.22		54	0.08	8	17	1.22		25	0.08	80	84.4
11	9	12	1.20		29	.10	9	9	1.20		59	.10	9	6	1.20		30	.08	79	83.9
12	10	2	1.20		35	.10		59	1.20	34	5	.10		56	1.22		35	.10	78	83.3
13		52	1.20		41	.12	10	49	1.22		11	.12	10	45	1.22		41	.12	77	82.7
14	11	42	1.20		48	.12	11	38	1.20		18	.12	11	34	1.22		48	.13	76	82.2
15	12	32	1.20		55	0.13	12	28	1.22		25	0.13	12	23	1.20		56	0.13	75	81.6
16	13	22	1.20	34	3	.13	13	17	1.20		33	.13	13	13	1.22	35	4	.13	74	81.0
17	14	12	1.22		11	.15	14	7	1.22		41	.15	14	2	1.22		12	.15	73	80.4
18	15	1	1.20		20	.15		56	1.22		50	.17		51	1.22		21	.15	72	79.8
19		51	1.22		29	.17	15	45	1.22	35	0	.17	15	40	1.25		30	.17	71	79.2
20	16	40	1.22		39	0.17	16	34	1.22		10	0.17	16	28	1.22		40	0.18	70	78.6
21	17	29	1.20		49	.18	17	23	1.22		20	.18	17	17	1.22		51	.18	69	78.0
22	18	19	1.22	35	0	.20	18	12	1.22		31	.20	18	6	1.25	36	2	.20	68	77.4
23	19	8	1.22		12	.20	19	1	1.22		43	.20		54	1.25		14	.20	67	76.8
24		57	1.22		24	.22		50	1.25		55	.22	19	42	1.25		26	.22	66	76.2
25	20	46	1.25		37	0.23	20	38	1.22	36	8	0.23	20	30	1.25		39	0.23	65	75.6
26	21	34	1.22		51	.23	21	27	1.25		22	.23	21	18	1.25		53	.25	64	74.9
27	22	23	1.25	36	5	.25	22	15	1.25		36	.25	22	6	1.25	37	8	.25	63	74.3
28	23	11	1.25		20	.27	23	3	1.25		51	.27		54	1.25		23	.25	62	73.6
29		59	1.25		36	.27		51	1.25	37	7	.27	23	42	1.28		38	.28	61	73.0
30	24	47	1.25		52	0.28	24	39	1.28		23	0.28	24	29	1.28		55	0.28	60	72.3
31	25	35	1.25	37	9	.30	25	26	1.28		40	.30	25	16	1.28	38	12	.30	59	71.7
32	26	23	1.25		27	.30	26	13	1.28		58	.32	26	3	1.28		30	.32	58	71.0
33	27	11	1.28		45	.32	27	0	1.28	38	17	.32		50	1.28		49	.32	57	70.3
34		58	1.28	38	4	.33		47	1.28		36	.33	27	37	1.28	39	8	.33	56	69.6
35	28	45	1.28		24	0.35	28	34	1.28		56	0.35	28	24	1.30		28	0.35	55	68.9
36	29	32	1.28		45	.37	29	21	1.30	39	17	.37	29	10	1.30		49	.37	54	68.1
37	30	19	1.30	39	7	.38	30	7	1.30		39	.38		56	1.30	40	11	.38	53	67.4
38	31	5	1.30		30	.38		53	1.30	40	2	.38	30	42	1.33		34	.38	52	66.7
39		51	1.30		53	.40	31	39	1.30		25	.42	31	27	1.33		57	.42	51	65.9
40	32	37	1.30	40	17	0.43	32	25	1.33		50	0.42	32	12	1.33	41	22	0.42	50	65.2
41	33	23	1.33		43	.43	33	10	1.33	41	15	.43		57	1.33		47	.45	49	64.4
42	34	8	1.33	41	9	.45		55	1.33		41	.47	33	42	1.36	42	14	.45	48	63.6
43		53	1.33		36	.48	34	40	1.36	42	9	.47	34	26	1.36		41	.48	47	62.8
44	35	38	1.36	42	5	.48	35	24	1.36		37	.48	35	10	1.40	43	10	.48	46	61.9
45	36	22			34		36	8		43	6			53			39		45	61.1
t	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′								a
	d = 33° 0′				d = 33° 30′				d = 34° 0′											

b / B	a = 33° 0′						a = 33° 30′						a = 34° 0′						c / C	a / β
	h \ d	60′/Δ		Z \ t		Δ/60′	h \ d	60′/Δ		Z \ t		Δ/60′	h \ d	60′/Δ		Z \ t		Δ/60′		
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
45	36 22	1.36		42 34		0.50	36 8	1.36		43 6		0.52	35 53	1.40		43 39		0.50	45	61.1
46	37 6	1.36		43 4		.53	52	1.40		37		.52	36 36	1.40		44 9		.53	44	60.3
47	50	1.40		36		.55	37 35	1.40		44 8		.55	37 19	1.40		41		.55	43	59.4
48	38 33	1.40		44 9		.57	38 18	1.43		41		.57	38 2	1.43		45 14		.57	42	58.5
49	39 16	1.40		43		.58	39 0	1.43		45 15		.58	44	1.43		48		.58	41	57.6
50	59	1.43		45 18		0.60	42	1.43		50		0.62	39 26	1.46		46 23		0.60	40	56.7
51	40 41	1.46		54		.63	40 24	1.46		46 27		.62	40 7	1.46		59		.63	39	55.7
52	41 22	1.46		46 32		.65	41 5	1.50		47 4		.65	48	1.50		47 37		.65	38	54.8
53	42 3	1.46		47 11		.67	45	1.50		43		.67	41 28	1.54		48 16		.67	37	53.8
54	44	1.50		51		.70	42 25	1.50		48 23		.70	42 7	1.54		56		.68	36	52.8
55	43 24	1.54		48 33		0.72	43 5	1.54		49 5		0.72	46	1.54		49 37		0.72	35	51.8
56	44 3	1.54		49 16		.75	44	1.58		48		.75	43 25	1.58		50 20		.75	34	50.7
57	42	1.58		50 1		.77	44 22	1.58		50 33		.77	44 3	1.62		51 5		.77	33	49.6
58	45 20	1.58		47		.80	45 0	1.62		51 19		.80	40	1.62		51		.78	32	48.5
59	58	1.62		51 35		.82	37	1.62		52 7		.82	45 17	1.67		52 38		.82	31	47.4
60	46 35	1.67		52 24		0.85	46 14	1.67		56		0.85	53	1.71		53 27		0.85	30	46.3
61	47 11	1.71		53 15		.88	50	1.71		53 47		.87	46 28	1.71		54 18		.87	29	45.1
62	46	1.71		54 8		.92	47 25	1.76		54 39		.90	47 3	1.76		55 10		.90	28	43.9
63	48 21	1.76		55 3		.93	59	1.76		55 33		.93	37	1.82		56 4		.92	27	42.7
64	55	1.82		59		.97	48 33	1.88		56 29		.95	48 10	1.88		59		.95	26	41.5
65	49 28	1.82		56 57		1.00	49 5	1.88		57 26		1.00	42	1.88		57 56		0.98	25	40.2
66	50 1	1.94		57 57		1.02	37	1.94		58 26		1.02	49 14	2.00		58 55		1.00	24	38.9
67	32	2.00		58 58		1.05	50 8	2.00		59 27		1.05	44	2.00		59 55		1.03	23	37.6
68	51 2	2.00		60 1		1.08	38	2.07		60 30		1.07	50 14	2.07		60 57		1.07	22	36.2
69	32	2.07		61 6		1.12	51 7	2.14		61 34		1.10	43	2.22		62 1		1.10	21	34.8
70	52 1	2.22		62 13		1.15	35	2.22		62 40		1.13	51 10	2.22		63 7		1.12	20	33.4
71	28	2.31		63 22		1.18	52 2	2.31		63 48		1.17	37	2.31		64 14		1.15	19	32.0
72	54	2.40		64 33		1.22	28	2.40		64 58		1.20	52 3	2.50		65 23		1.18	18	30.5
73	53 19	2.50		65 46		1.23	53	2.50		66 10		1.23	27	2.61		66 34		1.20	17	29.0
74	43	2.61		67 0		1.27	53 17	2.73		67 24		1.25	50	2.73		67 46		1.23	16	27.5
75	54 6	2.73		68 16		1.30	39	2.73		68 39		1.27	53 12	2.86		69 0		1.27	15	25.9
76	28	3.00		69 34		1.33	54 1	3.00		69 55		1.32	33	3.00		70 16		1.28	14	24.3
77	48	3.16		70 54		1.35	21	3.33		71 14		1.33	53	3.33		71 33		1.32	13	22.7
78	55 7	3.33		72 15		1.38	39	3.53		72 34		1.35	54 11	3.53		72 52		1.33	12	21.1
79	25	3.75		73 38		1.40	56	3.75		73 55		1.38	28	3.75		74 12		1.37	11	19.4
80	41	4.00		75 2		1.42	55 12	4.00		75 18		1.40	44	4.29		75 34		1.38	10	17.7
81	56	4.62		76 27		1.45	27	4.62		76 42		1.42	58	4.62		76 57		1.40	9	16.0
82	56 9	5.00		77 54		1.47	40	5.00		78 7		1.45	55 11	5.45		78 21		1.42	8	14.3
83	21	6.00		79 22		1.48	52	6.00		79 34		1.47	22	6.00		79 46		1.43	7	12.5
84	31	6.67		80 51		1.50	56 2	7.50		81 2		1.47	32	6.67		81 12		1.43	6	10.8
85	40	8.57		82 21		1.52	10	8.57		82 30		1.48	41	8.57		82 38		1.47	5	9.0
86	47	10.0		83 52		1.52	17	10.0		83 59		1.50	48	12.0		84 6		1.47	4	7.2
87	53	15.0		85 23		1.53	23	15.0		85 29		1.50	53	15.0		85 34		1.47	3	5.4
88	57	30.0		86 55		1.53	27	30.0		86 59		1.50	57	30.0		87 2		1.48	2	3.6
89	59	60.0		88 27		1.55	29	60.0		88 29		1.52	59	60.0		88 31		1.48	1	1.8
90	57 0			90 0			30			90 0			56 0			90 0			0	0.0
t	a	60′/Δ		b		Δ/60′	a	60′/Δ		b		Δ/60′	a	60′/Δ		b		Δ/60′		a
	d = 33° 0′						d = 33° 30′						d = 34° 0′							

b / B	a = 34° 30′ h / d	60′/Δ	Z / t	Δ/60′	a = 35° 0′ h / d	60′/Δ	Z / t	Δ/60′	a = 35° 30′ h / d	60′/Δ	Z / t	Δ/60′	c / C	a / β
°	° ′		° ′		° ′		° ′		° ′		° ′		°	°
0	0 0	1.22	34 30	0.00	0 0	1.22	35 0	0.00	0 0	1.22	35 30	0.00	**90**	90.0
1	49	1.20	30	.02	49	1.22	0	.02	49	1.22	30	.02	89	89.4
2	1 39	1.22	31	.02	1 38	1.22	1	.02	1 38	1.22	31	.02	88	88.9
3	2 28	1.20	32	.03	2 27	1.20	2	.03	2 27	1.25	32	.03	87	88.3
4	3 18	1.22	34	.03	3 17	1.22	4	.03	3 15	1.22	34	.03	86	87.7
5	4 7	1.20	36	0.05	4 6	1.22	6	0.05	4 4	1.22	36	0.05	85	87.1
6	57	1.22	39	.05	55	1.22	9	.05	53	1.22	39	.05	84	86.6
7	5 46	1.22	42	.07	5 44	1.22	12	.07	5 42	1.25	42	.07	83	86.0
8	6 35	1.22	46	.07	6 33	1.22	16	.07	6 30	1.22	46	.07	82	85.4
9	7 24	1.20	50	.08	7 22	1.22	20	.08	7 19	1.22	50	.08	81	84.8
10	8 14	1.22	55	0.08	8 11	1.22	25	0.08	8 8	1.25	55	0.08	**80**	84.2
11	9 3	1.22	35 0	.10	9 0	1.25	30	.10	56	1.22	36 0	.10	79	83.6
12	52	1.22	6	.10	48	1.22	36	.10	9 45	1.25	6	.10	78	83.0
13	10 41	1.22	12	.12	10 37	1.22	42	.12	10 33	1.22	12	.12	77	82.5
14	11 30	1.22	19	.12	11 26	1.25	49	.12	11 22	1.25	19	.13	76	81.9
15	12 19	1.22	26	0.13	12 14	1.22	56	0.13	12 10	1.25	27	0.13	75	81.3
16	13 8	1.22	34	.13	13 3	1.25	36 4	.15	58	1.25	35	.13	74	80.7
17	57	1.25	42	.15	51	1.22	13	.15	13 46	1.25	43	.15	73	80.1
18	14 45	1.22	51	.17	14 40	1.25	22	.15	14 34	1.25	52	.17	72	79.4
19	15 34	1.25	36 1	.17	15 28	1.25	31	.17	15 22	1.25	37 2	.17	71	78.8
20	16 22	1.22	11	0.18	16 16	1.25	41	0.18	16 10	1.25	12	0.18	**70**	78.2
21	17 11	1.25	22	.18	17 4	1.25	52	.20	58	1.28	23	.18	69	77.6
22	59	1.25	33	.20	52	1.25	37 4	.20	17 45	1.25	34	.20	68	77.0
23	18 47	1.25	45	.20	18 40	1.25	16	.20	18 33	1.28	46	.22	67	76.3
24	19 35	1.25	57	.22	19 28	1.28	28	.22	19 20	1.28	59	.22	66	75.7
25	20 23	1.25	37 10	0.23	20 15	1.25	41	0.23	20 7	1.28	38 12	0.23	65	75.0
26	21 11	1.28	24	.25	21 3	1.28	55	.25	54	1.28	26	.25	64	74.4
27	58	1.25	39	.25	50	1.28	38 10	.25	21 41	1.28	41	.25	63	73.7
28	22 46	1.28	54	.27	22 37	1.28	25	.27	22 28	1.28	56	.27	62	73.0
29	23 33	1.28	38 10	.27	23 24	1.28	41	.27	23 15	1.30	39 12	.28	61	72.4
30	24 20	1.28	26	0.28	24 11	1.30	57	0.30	24 1	1.30	29	0.28	**60**	71.7
31	25 7	1.28	43	.30	57	1.28	39 15	.30	47	1.30	46	.30	59	71.0
32	54	1.30	39 1	.32	25 44	1.30	33	.32	25 33	1.30	40 4	.32	58	70.3
33	26 40	1.30	20	.33	26 30	1.30	52	.32	26 19	1.30	23	.33	57	69.6
34	27 26	1.30	40	.33	27 16	1.30	40 11	.33	27 5	1.33	43	.33	56	68.9
35	28 12	1.30	40 0	0.35	28 2	1.33	31	0.35	50	1.33	41 3	0.35	**55**	68.1
36	58	1.30	21	.37	47	1.33	52	.37	28 35	1.33	24	.37	54	67.4
37	29 44	1.33	43	.38	29 32	1.33	41 14	.38	29 20	1.33	46	.38	53	66.6
38	30 29	1.33	41 6	.40	30 17	1.33	37	.40	30 5	1.36	42 9	.40	52	65.9
39	31 14	1.33	30	.40	31 2	1.36	42 1	.42	49	1.36	33	.42	51	65.1
40	59	1.33	54	0.42	46	1.36	26	0.42	31 33	1.36	58	0.42	**50**	64.3
41	32 44	1.36	42 19	.45	32 30	1.36	51	.45	32 17	1.40	43 23	.45	49	63.5
42	33 28	1.36	46	.45	33 14	1.36	43 18	.45	33 0	1.40	50	.45	48	62.7
43	34 12	1.36	43 13	.48	58	1.40	45	.48	43	1.40	44 17	.47	47	61.9
44	56	1.40	42	.48	34 41	1.40	44 14	.48	34 26	1.40	45	.50	46	61.0
45	35 39		44 11		35 24		43		35 9		45 15		**45**	60.2

t	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a
	d = 34° 30′				d = 35° 0′				d = 35° 30′				

b / B	a = 34° 30′						a = 35° 0′						a = 35° 30′						c / C	a / β
	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′		
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
45	35 39	1.40		44 11		0.52	35 24	1.43		44 43		0.52	35 9	1.43		45 15		0.50	45	60.2
46	36 22	1.43		42		.52	36 6	1.43		45 14		.52	51	1.43		45		.53	44	59.3
47	37 4	1.43		45 13		.55	48	1.43		45		.55	36 33	1.46		46 17		.55	43	58.4
48	46	1.43		46		.57	37 30	1.46		46 18		.57	37 14	1.46		50		.57	42	57.5
49	38 28	1.46		46 20		.58	38 11	1.46		52		.58	55	1.50		47 24		.58	41	56.6
50	39 9	1.46		55		0.60	52	1.50		47 27		0.60	38 35	1.50		59		0.60	40	55.6
51	50	1.50		47 31		.63	39 32	1.50		48 3		.63	39 15	1.54		48 35		.62	39	54.7
52	40 30	1.50		48 9		.65	40 12	1.50		41		.63	54	1.54		49 12		.65	38	53.7
53	41 10	1.54		48		.67	52	1.54		49 19		.67	40 33	1.54		51		.67	37	52.7
54	49	1.54		49 28		.68	41 31	1.58		59		.70	41 12	1.58		50 31		.68	36	51.7
55	42 28	1.58		50 9		0.72	42 9	1.58		50 41		0.70	50	1.62		51 12		0.70	35	50.7
56	43 6	1.62		52		.73	47	1.62		51 23		.73	42 27	1.62		54		.73	34	49.6
57	43	1.62		51 36		.77	43 24	1.67		52 7		.77	43 4	1.67		52 38		.75	33	48.5
58	44 20	1.67		52 22		.78	44 0	1.67		53		.78	40	1.71		53 23		.78	32	47.4
59	56	1.67		53 9		.82	36	1.71		53 40		.80	44 15	1.71		54 10		.80	31	46.3
60	45 32	1.71		58		0.83	45 11	1.71		54 28		0.83	50	1.76		58		0.83	30	45.2
61	46 7	1.76		54 48		.87	46	1.76		55 18		.87	45 24	1.82		55 48		.85	29	44.0
62	41	1.76		55 40		.88	46 20	1.82		56 10		.88	57	1.82		56 39		.88	28	42.8
63	47 15	1.82		56 33		.92	53	1.88		57 3		.90	46 30	1.88		57 32		.90	27	41.6
64	48	1.88		57 28		.95	47 25	1.94		57		.93	47 2	1.94		58 26		.92	26	40.4
65	48 20	1.94		58 25		0.97	56	1.94		58 53		0.97	33	2.00		59 21		0.95	25	39.1
66	51	2.00		59 23		1.00	48 27	2.07		59 51		.98	48 3	2.07		60 18		.98	24	37.8
67	49 21	2.07		60 23		1.03	56	2.07		60 50		1.02	32	2.07		61 17		1.02	23	36.5
68	50	2.14		61 25		1.05	49 25	2.14		61 51		1.05	49 1	2.22		62 18		1.03	22	35.2
69	50 18	2.22		62 28		1.08	53	2.22		62 54		1.07	28	2.22		63 20		1.05	21	33.8
70	45	2.31		63 33		1.10	50 20	2.31		63 58		1.10	55	2.40		64 23		1.08	20	32.4
71	51 11	2.40		64 39		1.13	46	2.50		65 4		1.12	50 20	2.50		65 28		1.12	19	31.0
72	36	2.50		65 47		1.17	51 10	2.50		66 11		1.15	44	2.50		66 35		1.13	18	29.5
73	52 0	2.61		66 57		1.20	34	2.61		67 20		1.18	51 8	2.73		67 43		1.15	17	28.1
74	23	2.73		68 9		1.22	57	2.86		68 31		1.20	30	2.86		68 52		1.18	16	26.6
75	45	2.86		69 22		1.25	52 18	3.00		69 43		1.22	51	3.00		70 3		1.22	15	25.0
76	53 6	3.16		70 37		1.27	38	3.16		70 56		1.25	52 11	3.16		71 16		1.23	14	23.5
77	25	3.33		71 53		1.28	57	3.33		72 11		1.28	30	3.53		72 30		1.25	13	21.9
78	43	3.53		73 10		1.32	53 15	3.75		73 28		1.28	47	3.75		73 45		1.27	12	20.3
79	54 0	4.00		74 29		1.33	31	4.00		74 45		1.32	53 3	4.00		75 1		1.30	11	18.7
80	15	4.29		75 49		1.37	46	4.29		76 4		1.33	18	4.62		76 19		1.32	10	17.1
81	29	4.62		77 11		1.37	54 0	4.62		77 24		1.37	31	5.00		77 38		1.33	9	15.4
82	42	5.45		78 33		1.40	13	5.45		78 46		1.37	43	5.45		78 58		1.33	8	13.8
83	53	6.00		79 57		1.40	24	6.67		80 8		1.38	54	6.00		80 18		1.37	7	12.1
84	55 3	7.50		81 21		1.42	33	7.50		81 31		1.38	54 4	7.50		81 40		1.37	6	10.4
85	11	8.57		82 46		1.43	41	8.57		82 54		1.42	12	10.0		83 2		1.38	5	8.7
86	18	12.0		84 12		1.45	48	12.0		84 19		1.42	18	12.0		84 25		1.38	4	7.0
87	23	15.0		85 39		1.45	53	15.0		85 44		1.42	23	15.0		85 48		1.40	3	5.2
88	27	30.0		87 6		1.45	57	30.0		87 9		1.42	27	30.0		87 12		1.40	2	3.5
89	29	60.0		88 33		1.45	59	60.0		88 34		1.43	29	60.0		88 36		1.40	1	1.7
90	30			90 0			55 0			90 0			30			90 0			0	0.0
t	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′		a
	d = 34° 30′						d = 35° 0′						d = 35° 30′							

b / B	a = 36° 0′						a = 36° 30′						a = 37° 0′						c / C	a / β
	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′		
°	°	′		°	′		°	′		°	′		°	′		°	′		°	°
0	0	0	1.22	36	0	0.00	0	0	1.25	36	30	0.00	0	0	1.25	37	0	0.00	90	90.0
1		49	1.25		0	.02		48	1.25		30	.02		48	1.25		0	.02	89	89.4
2	1	37	1.22		1	.02	1	36	1.22		31	.02	1	36	1.25		1	.02	88	88.8
3	2	26	1.25		2	.03	2	25	1.25		32	.03	2	24	1.25		2	.03	87	88.2
4	3	14	1.22		4	.03	3	13	1.25		34	.03	3	12	1.28		4	.03	86	87.6
5	4	3	1.25		6	0.05	4	1	1.25		36	0.05		59	1.25		6	0.05	85	87.0
6		51	1.25		9	.05		49	1.25		39	.05	4	47	1.25		9	.05	84	86.4
7	5	39	1.22		12	.07	5	37	1.25		42	.07	5	35	1.25		12	.07	83	85.8
8	6	28	1.25		16	.07	6	25	1.25		46	.07	6	23	1.25		16	.07	82	85.2
9	7	16	1.22		20	.08	7	13	1.25		50	.08	7	11	1.28		20	.08	81	84.6
10	8	5	1.25		25	0.08	8	1	1.25		55	0.10		58	1.25		25	0.10	80	84.0
11		53	1.25		30	.10		49	1.25	37	1	.10	8	46	1.25		31	.10	79	83.4
12	9	41	1.25		36	.12	9	37	1.25		7	.10	9	34	1.28		37	.10	78	82.8
13	10	29	1.25		43	.12	10	25	1.25		13	.12	10	21	1.28		43	.12	77	82.2
14	11	17	1.25		50	.12	11	13	1.28		20	.12	11	8	1.25		50	.12	76	81.6
15	12	5	1.25		57	0.13	12	0	1.25		27	0.13		56	1.28		57	0.13	75	80.9
16		53	1.25	37	5	.13		48	1.25		35	.15	12	43	1.28	38	5	.15	74	80.3
17	13	41	1.25		13	.15	13	36	1.28		44	.15	13	30	1.28		14	.15	73	79.7
18	14	29	1.28		22	.17	14	23	1.28		53	.17	14	17	1.28		23	.17	72	79.1
19	15	16	1.25		32	.18	15	10	1.28	38	3	.17	15	4	1.28		33	.18	71	78.4
20	16	4	1.28		43	0.18		57	1.28		13	0.18		51	1.28		44	0.18	70	77.8
21		51	1.28		54	.18	16	44	1.28		24	.20	16	38	1.28		55	.18	69	77.1
22	17	38	1.28	38	5	.20	17	31	1.28		36	.20	17	25	1.30	39	6	.20	68	76.5
23	18	25	1.28		17	.22	18	18	1.28		48	.22	18	11	1.30		18	.22	67	75.8
24	19	12	1.28		30	.22	19	5	1.28	39	1	.22		57	1.30		31	.23	66	75.2
25		59	1.28		43	0.23		52	1.30		14	0.23	19	43	1.30		45	0.23	65	74.5
26	20	46	1.28		57	.25	20	38	1.30		28	.25	20	29	1.30		59	.23	64	73.8
27	21	33	1.30	39	12	.25	21	24	1.30		43	.25	21	15	1.30	40	13	.27	63	73.1
28	22	19	1.30		27	.27	22	10	1.30		58	.27	22	1	1.30		29	.27	62	72.5
29	23	5	1.30		43	.28		56	1.30	40	14	.28		47	1.33		45	.28	61	71.8
30		51	1.30	40	0	0.28	23	42	1.33		31	0.28	23	32	1.33	41	2	0.28	60	71.0
31	24	37	1.30		17	.30	24	27	1.30		48	.30	24	17	1.33		19	.30	59	70.3
32	25	23	1.30		35	.32	25	13	1.33	41	6	.32	25	2	1.33		37	.32	58	69.6
33	26	9	1.33		54	.33		58	1.33		25	.33		47	1.33		56	.33	57	68.9
34		54	1.33	41	14	.33	26	43	1.33		45	.35	26	32	1.36	42	16	.35	56	68.1
35	27	39	1.33		34	0.37	27	28	1.36	42	6	0.35	27	16	1.36		37	0.35	55	67.4
36	28	24	1.36		56	.37	28	12	1.36		27	.37	28	0	1.36		58	.37	54	66.6
37	29	8	1.36	42	18	.38		56	1.36		49	.38		44	1.40	43	20	.38	53	65.9
38		52	1.36		41	.38	29	40	1.36	43	12	.40	29	27	1.40		43	.40	52	65.1
39	30	36	1.36	43	4	.42	30	24	1.40		36	.42	30	10	1.40	44	7	.42	51	64.3
40	31	20	1.40		29	0.43	31	7	1.40	44	1	0.42		53	1.40		32	0.43	50	63.5
41	32	3	1.40		55	.43		50	1.40		26	.45	31	36	1.43		58	.43	49	62.7
42		46	1.40	44	21	.47	32	33	1.43		53	.45	32	18	1.43	45	24	.47	48	61.8
43	33	29	1.40		49	.47	33	15	1.43	45	20	.48	33	0	1.43		52	.47	47	61.0
44	34	12	1.43	45	17	.48		57	1.43		49	.48		42	1.46	46	20	.48	46	60.1
45		54			46		34	39		46	18		34	23			49		45	59.3

t	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a
	d = 36° 0′				d = 36° 30′				d = 37° 0′				

b / B	a = 36° 0′					a = 36° 30′					a = 37° 0′					c / C	a / β
	h \ d	60′/Δ	Z \ t	Δ/60′		h \ d	60′/Δ	Z \ t	Δ/60′		h \ d	60′/Δ	Z \ t	Δ/60′			
°	° ′		° ′			° ′		° ′			° ′		° ′			°	°
45	34 54	1.46	45 46	0.52		34 39	1.46	46 18	0.50		34 23	1.46	46 49	0.52		45	59.3
46	35 35	1.46	46 17	.53		35 20	1.46	48	.53		35 4	1.50	47 20	.52		44	58.4
47	36 16	1.46	49	.53		36 1	1.50	47 20	.55		44	1.50	51	.55		43	57.5
48	57	1.46	47 21	.57		41	1.50	53	.55		36 24	1.50	48 24	.55		42	56.6
49	37 38	1.50	55	.58		37 21	1.50	48 26	.58		37 4	1.54	57	.58		41	55.6
50	38 18	1.54	48 30	0.60		38 1	1.54	49 1	0.60		43	1.54	49 32	0.60		40	54.7
51	57	1.54	49 6	.62		40	1.58	37	.62		38 22	1.58	50 8	.62		39	53.7
52	39 36	1.54	43	.65		39 18	1.58	50 14	.63		39 0	1.58	45	.63		38	52.7
53	40 15	1.58	50 22	.67		56	1.58	52	.67		38	1.62	51 23	.67		37	51.7
54	53	1.62	51 2	.68		40 34	1.62	51 32	.68		40 15	1.62	52 3	.67		36	50.7
55	41 30	1.62	43	0.70		41 11	1.67	52 13	0.70		52	1.67	43	0.70		35	49.7
56	42 7	1.67	52 25	.73		47	1.67	55	.73		41 28	1.71	53 25	.72		34	48.6
57	43	1.67	53 9	.75		42 23	1.71	53 39	.75		42 3	1.71	54 8	.75		33	47.5
58	43 19	1.71	54	.77		58	1.71	54 24	.77		38	1.76	53	.77		32	46.4
59	54	1.71	54 40	.80		43 33	1.76	55 10	.78		43 12	1.76	55 39	.78		31	45.3
60	44 29	1.82	55 28	0.82		44 7	1.82	57	0.82		46	1.82	56 26	0.82		30	44.1
61	45 2	1.82	56 17	.85		40	1.82	56 46	.83		44 19	1.88	57 15	.83		29	43.0
62	35	1.88	57 8	.87		45 13	1.88	57 36	.87		51	1.94	58 5	.85		28	41.8
63	46 7	1.88	58 0	.90		45	1.94	58 28	.88		45 22	2.00	56	.88		27	40.6
64	39	2.00	54	.92		46 16	2.00	59 21	.92		52	2.00	59 49	.90		26	39.4
65	47 9	2.00	59 49	0.95		46	2.07	60 16	0.93		46 22	2.07	60 43	0.93		25	38.1
66	39	2.07	60 46	.97		47 15	2.14	61 12	.97		51	2.14	61 39	.95		24	36.8
67	48 8	2.14	61 44	1.00		43	2.14	62 10	.98		47 19	2.22	62 36	.97		23	35.5
68	36	2.22	62 44	1.02		48 11	2.22	63 9	1.02		46	2.22	63 34	1.00		22	34.2
69	49 3	2.31	63 45	1.05		38	2.40	64 10	1.03		48 13	2.40	64 34	1.02		21	32.8
70	29	2.40	64 48	1.07		49 3	2.40	65 12	1.05		38	2.50	65 35	1.05		20	31.5
71	54	2.50	65 52	1.10		28	2.50	66 15	1.08		49 2	2.50	66 38	1.07		19	30.1
72	50 18	2.61	66 58	1.12		52	2.73	67 20	1.10		26	2.73	67 42	1.10		18	28.6
73	41	2.73	68 5	1.15		50 14	2.73	68 26	1.13		48	2.86	68 48	1.12		17	27.2
74	51 3	2.86	69 14	1.17		36	3.00	69 34	1.15		50 9	3.00	69 55	1.13		16	25.7
75	24	3.16	70 24	1.18		56	3.16	70 43	1.18		29	3.16	71 3	1.15		15	24.3
76	43	3.33	71 35	1.22		51 15	3.33	71 54	1.18		48	3.33	72 12	1.18		14	22.7
77	52 1	3.53	72 48	1.23		33	3.53	73 5	1.22		51 6	3.75	73 23	1.20		13	21.2
78	18	3.75	74 2	1.25		50	3.75	74 18	1.25		22	4.00	74 35	1.20		12	19.7
79	34	4.00	75 17	1.27		52 6	4.29	75 33	1.25		37	4.49	75 47	1.23		11	18.1
80	49	4.62	76 33	1.30		20	4.62	76 48	1.27		51	4.62	77 1	1.25		10	16.5
81	53 2	5.00	77 51	1.30		33	5.00	78 4	1.28		52 4	5.00	78 16	1.27		9	14.9
82	14	5.45	79 9	1.33		45	5.45	79 21	1.30		16	6.00	79 32	1.28		8	13.3
83	25	6.67	80 29	1.33		56	6.67	80 39	1.32		26	6.67	80 49	1.28		7	11.7
84	34	7.50	81 49	1.35		53 5	7.50	81 58	1.32		35	7.50	82 6	1.30		6	10.0
85	42	8.57	83 10	1.35		13	10.0	83 17	1.33		43	10.0	83 24	1.32		5	8.4
86	49	12.0	84 31	1.37		19	12.0	84 37	1.33		49	12.0	84 43	1.32		4	6.7
87	54	20.0	85 53	1.37		24	20.0	85 57	1.35		54	20.0	86 2	1.32		3	5.0
88	57	30.0	87 15	1.37		27	30.0	87 18	1.35		57	30.0	87 21	1.32		2	3.4
89	59	60.0	88 37	1.38		29	60.0	88 39	1.35		59	60.0	88 40	1.33		1	1.7
90	54 0		90 0			30		90 0			53 0		90 0			0	0.0
t	a	60′/Δ	b	Δ/60′		a	60′/Δ	b	Δ/60′		a	60′/Δ	b	Δ/60′			a
	d = 36° 0′					d = 36° 30′					d = 37° 0′						

b / B	a = 37° 30′						a = 38° 0′						a = 38° 30′						c / C	a / β
	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′		
°	°	′		°	′		°	′		°	′		°	′		°	′		°	°
0	0	0	1.25	37	30	0.00	0	0	1.28	38	0	0.00	0	0	1.28	38	30	0.00	90	90.0
1		48	1.28		30	.02		47	1.25		0	.02		47	1.28		30	.02	89	89.4
2	1	35	1.25		31	.02	1	35	1.28		1	.02	1	34	1.28		31	.02	88	88.8
3	2	23	1.28		32	.03	2	22	1.28		2	.03	2	21	1.28		32	.03	87	88.2
4	3	10	1.25		34	.03	3	9	1.28		4	.03	3	8	1.28		34	.03	86	87.5
5		58	1.25		36	0.05		56	1.25		6	0.05		55	1.28		36	0.05	85	86.9
6	4	46	1.28		39	.05	4	44	1.28		9	.05	4	42	1.30		39	.05	84	86.3
7	5	33	1.28		42	.07	5	31	1.28		12	.07	5	28	1.28		42	.07	83	85.7
8	6	20	1.25		46	.08	6	18	1.28		16	.08	6	15	1.28		46	.08	82	85.1
9	7	8	1.28		51	.08	7	5	1.28		21	.08	7	2	1.28		51	.08	81	84.4
10		55	1.28		56	0.08		52	1.28		26	0.08		49	1.30		56	0.08	80	83.8
11	8	42	1.25	38	1	.10	8	39	1.28		31	.10	8	35	1.28	39	1	.10	79	83.2
12	9	30	1.28		7	.10	9	26	1.28		37	.10	9	22	1.30		7	.12	78	82.5
13	10	17	1.28		13	.12	10	13	1.30		43	.12	10	8	1.28		14	.12	77	81.9
14	11	4	1.28		20	.13		59	1.28		50	.13		55	1.30		21	.12	76	81.3
15		51	1.28		28	0.13	11	46	1.28		58	0.13	11	41	1.28		28	0.13	75	80.6
16	12	38	1.28		36	.15	12	33	1.30	39	6	.15	12	28	1.30		36	.15	74	80.0
17	13	25	1.28		45	.15	13	19	1.28		15	.15	13	14	1.30		45	.15	73	79.3
18	14	12	1.30		54	.17	14	6	1.30		24	.17	14	0	1.30		54	.17	72	78.7
19		58	1.28	39	4	.17		52	1.30		34	.17		46	1.30	40	4	.18	71	78.0
20	15	45	1.30		14	0.18	15	38	1.30		44	0.18	15	32	1.33		15	0.18	70	77.4
21	16	31	1.30		25	.20	16	24	1.30		55	.20	16	17	1.30		26	.20	69	76.7
22	17	17	1.30		37	.20	17	10	1.30	40	7	.20	17	3	1.33		38	.20	68	76.0
23	18	3	1.30		49	.22		56	1.30		19	.22		48	1.30		50	.22	67	75.4
24		49	1.30	40	2	.22	18	42	1.33		32	.23	18	34	1.33	41	3	.22	66	74.7
25	19	35	1.30		15	0.23	19	27	1.30		46	0.23	19	19	1.33		16	0.23	65	74.0
26	20	21	1.30		29	.25	20	13	1.33	41	0	.25	20	4	1.33		30	.25	64	73.3
27	21	7	1.33		44	.27		58	1.33		15	.25		49	1.33		45	.27	63	72.6
28		52	1.33	41	0	.27	21	43	1.33		30	.27	21	34	1.36	42	1	.27	62	71.9
29	22	37	1.33		16	.28	22	28	1.36		46	.28	22	18	1.36		17	.28	61	71.2
30	23	22	1.33		33	0.28	23	12	1.33	42	3	0.30	23	2	1.36		34	0.30	60	70.4
31	24	7	1.33		50	.30		57	1.36		21	.30		46	1.36		52	.30	59	69.7
32		52	1.36	42	8	.32	24	41	1.36		39	.32	24	30	1.36	43	10	.32	58	69.0
33	25	36	1.36		27	.33	25	25	1.36		58	.33	25	14	1.40		29	.33	57	68.2
34	26	20	1.36		47	.35	26	9	1.40	43	18	.35		57	1.40		49	.35	56	67.4
35	27	4	1.36	43	8	0.35		52	1.40		39	0.35	26	40	1.40	44	10	0.35	55	66.7
36		48	1.40		29	.37	27	35	1.40	44	0	.37	27	23	1.40		31	.37	54	65.9
37	28	31	1.40		51	.38	28	18	1.40		22	.38	28	6	1.43		53	.38	53	65.1
38	29	14	1.40	44	14	.40	29	1	1.40		45	.40		48	1.43	45	16	.40	52	64.3
39		57	1.40		38	.42		44	1.43	45	9	.42	29	30	1.43		40	.42	51	63.5
40	30	40	1.43	45	3	0.42	30	26	1.43		34	0.43	30	12	1.43	46	5	0.43	50	62.7
41	31	22	1.43		28	.45	31	8	1.46	46	0	.43		54	1.46		31	.43	49	61.8
42	32	4	1.46		55	.47		49	1.46		26	.45	31	35	1.46		57	.45	48	61.0
43		45	1.46	46	23	.47	32	30	1.46		53	.48	32	16	1.50	47	24	.48	47	60.1
44	33	26	1.46		51	.48	33	11	1.46	47	22	.48		56	1.50		53	.48	46	59.3
45	34	7		47	20			52			51		33	36		48	22		45	58.4
t	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′		a
	d = 37° 30′						d = 38° 0′						d = 38° 30′							

b / B	$a = 37° 30'$						$a = 38° 0'$						$a = 38° 30'$						c / C	a / β
	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′		
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
45	34 7		1.46	47 20		0.52	33 52		1.50	47 51		0.52	33 36		1.50	48 22		0.50	45	58.4
46	48		1.50	51		.52	34 32		1.50	48 22		.52	34 16		1.54	52		.53	44	57.5
47	35 28		1.50	48 22		.55	35 12		1.54	53		.53	55		1.54	49 24		.53	43	56.6
48	36 8		1.54	55		.55	51		1.54	49 25		.57	35 34		1.58	56		.55	42	55.6
49	47		1.54	49 28		.58	36 30		1.58	59		.57	36 12		1.58	50 29		.58	41	54.7
50	37 26		1.58	50 3		0.60	37 8		1.58	50 33		0.60	50		1.58	51 4		0.58	40	53.7
51	38 4		1.58	39		.62	46		1.62	51 9		.62	37 28		1.62	39		.62	39	52.8
52	42		1.62	51 16		.63	38 23		1.62	46		.63	38 5		1.67	52 16		.62	38	51.8
53	39 19		1.62	54		.65	39 0		1.67	52 24		.65	41		1.67	53		.65	37	50.8
54	56		1.67	52 33		.67	36		1.67	53 3		.67	39 17		1.71	53 32		.67	36	49.7
55	40 32		1.67	53 13		0.70	40 12		1.71	43		0.68	52		1.71	54 12		0.70	35	48.7
56	41 8		1.71	55		.72	47		1.71	54 24		.72	40 27		1.76	54		.70	34	47.6
57	43		1.76	54 38		.73	41 22		1.76	55 7		.73	41 1		1.76	55 36		.73	33	46.5
58	42 17		1.76	55 22		.77	56		1.82	51		.75	35		1.82	56 20		.75	32	45.4
59	51		1.82	56 8		.78	42 29		1.82	56 36		.78	42 8		1.88	57 5		.77	31	44.3
60	43 24		1.88	55		0.80	43 2		1.88	57 23		0.80	40		1.88	51		0.78	30	43.2
61	56		1.88	57 43		.82	34		1.94	58 11		.82	43 12		1.94	58 38		.82	29	42.0
62	44 28		1.94	58 32		.85	44 5		1.94	59 0		.83	43		2.00	59 27		.83	28	40.8
63	59		2.00	59 23		.88	36		2.00	50		.87	44 13		2.07	60 17		.85	27	39.6
64	45 29		2.07	60 16		.88	45 6		2.07	60 42		.88	42		2.07	61 8		.88	26	38.4
65	58		2.07	61 9		0.92	35		2.14	61 35		0.92	45 11		2.22	62 1		0.90	25	37.1
66	46 27		2.14	62 4		.95	46 3		2.22	62 30		.93	38		2.22	55		.92	24	35.9
67	55		2.31	63 1		.97	30		2.31	63 26		.95	46 5		2.31	63 50		.95	23	34.6
68	47 21		2.31	59		.98	56		2.31	64 23		.98	31		2.40	64 47		.97	22	33.3
69	47		2.40	64 58		1.02	47 22		2.50	65 22		1.00	56		2.50	65 45		.98	21	31.9
70	48 12		2.50	65 59		1.03	46		2.50	66 22		1.02	47 20		2.50	66 44		1.00	20	30.6
71	36		2.61	67 1		1.05	48 10		2.61	67 23		1.03	44		2.73	67 44		1.03	19	29.2
72	59		2.73	68 4		1.08	33		2.86	68 25		1.07	48 6		2.86	68 46		1.05	18	27.8
73	49 21		2.86	69 9		1.10	54		2.86	69 29		1.08	27		3.00	69 49		1.07	17	26.4
74	42		3.00	70 15		1.12	49 15		3.16	70 34		1.10	47		3.16	70 53		1.08	16	25.0
75	50 2		3.33	71 22		1.13	34		3.33	71 40		1.13	49 6		3.33	71 58		1.12	15	23.5
76	20		3.33	72 30		1.17	52		3.53	72 48		1.13	24		3.53	73 5		1.13	14	22.0
77	38		3.75	73 40		1.17	50 9		3.75	73 56		1.17	41		3.75	74 13		1.13	13	20.5
78	54		4.00	74 50		1.20	25		4.00	75 6		1.18	57		4.00	75 21		1.17	12	19.0
79	51 9		4.29	76 2		1.22	40		4.29	76 17		1.18	50 12		4.62	76 31		1.17	11	17.5
80	23		4.62	77 15		1.23	54		5.00	77 28		1.22	25		5.00	77 41		1.18	10	16.0
81	36		5.45	78 29		1.23	51 6		5.45	78 41		1.22	37		5.45	78 52		1.20	9	14.4
82	47		6.00	79 43		1.25	17		6.00	79 54		1.23	48		6.00	80 4		1.22	8	12.9
83	57		6.67	80 58		1.27	27		6.67	81 8		1.25	58		7.50	81 17		1.23	7	11.3
84	52 6		8.57	82 14		1.28	36		8.57	82 23		1.25	51 6		8.57	82 31		1.23	6	9.7
85	13		10.0	83 31		1.28	43		10.0	83 38		1.27	13		10.0	83 45		1.23	5	8.1
86	19		12.0	84 48		1.30	49		12.0	84 54		1.27	19		12.0	84 59		1.25	4	6.5
87	24		20.0	86 6		1.30	54		20.0	86 10		1.27	24		20.0	86 14		1.25	3	4.9
88	27		30.0	87 24		1.30	57		30.0	87 26		1.28	27		30.0	87 29		1.25	2	3.2
89	29		60.0	88 42		1.30	59		60.0	88 43		1.28	29		60.0	88 44		1.27	1	1.6
90	30			90 0			52 0			90 0			30			90 0			0	0.0
t	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′		a
	$d = 37° 30'$						$d = 38° 0'$						$d = 38° 30'$							

b / B	$a = 39° 0'$						$a = 39° 30'$						$a = 40° 0'$						c / C	α / β
	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′		
°	°	′		°	′		°	′		°	′		°	′		°	′		°	°
0	0	0	1.28	39	0	0.00	0	0	1.30	39	30	0.00	0	0	1.30	40	0	0.00	90	90.0
1		47	1.30		0	.02		46	1.28		30	.02		46	1.30		0	.02	89	89.4
2	1	33	1.28		1	.02	1	33	1.30		31	.02	1	32	1.30		1	.02	88	88.7
3	2	20	1.28		2	.03	2	19	1.30		32	.03	2	18	1.30		2	.03	87	88.1
4	3	7	1.30		4	.03	3	5	1.30		34	.03	3	4	1.30		4	.03	86	87.5
5		53	1.28		6	0.05		51	1.28		36	0.05		50	1.30		6	0.05	85	86.8
6	4	40	1.30		9	.07	4	38	1.30		39	.07	4	36	1.33		9	.07	84	86.2
7	5	26	1.28		13	.07	5	24	1.30		43	.07	5	21	1.30		13	.07	83	85.5
8	6	13	1.30		17	.07	6	10	1.30		47	.07	6	7	1.30		17	.07	82	84.9
9		59	1.30		21	.08		56	1.30		51	.08		53	1.30		21	.08	81	84.2
10	7	45	1.28		26	0.08	7	42	1.30		56	0.08	7	39	1.33		26	0.08	80	83.6
11	8	32	1.30		31	.10	8	28	1.30	40	1	.10	8	24	1.30		31	.10	79	83.0
12	9	18	1.30		37	.12	9	14	1.30		7	.12	9	10	1.33		37	.12	78	82.3
13	10	4	1.30		44	.12	10	0	1.30		14	.12		55	1.30		44	.12	77	81.6
14		50	1.30		51	.13		46	1.33		21	.13	10	41	1.33		51	.13	76	81.0
15	11	36	1.30		59	0.13	11	31	1.30		29	0.13	11	26	1.33		59	0.13	75	80.3
16	12	22	1.30	40	7	.15	12	17	1.33		37	.15	12	11	1.33	41	7	.15	74	79.7
17	13	8	1.30		16	.15	13	2	1.30		46	.15		56	1.33		16	.15	73	79.0
18		54	1.30		25	.17		48	1.33		55	.17	13	41	1.33		25	.17	72	78.3
19	14	40	1.33		35	.17	14	33	1.33	41	5	.18	14	26	1.33		35	.18	71	77.6
20	15	25	1.33		45	0.18	15	18	1.33		16	0.18	15	11	1.33		46	0.18	70	77.0
21	16	10	1.33		56	.20	16	3	1.33		27	.20		56	1.33		57	.20	69	76.3
22		55	1.33	41	8	.20		48	1.33		39	.20	16	41	1.36	42	9	.20	68	75.6
23	17	40	1.33		20	.22	17	33	1.33		51	.22	17	25	1.36		21	.22	67	74.9
24	18	25	1.33		33	.23	18	18	1.36	42	4	.22	18	9	1.36		34	.23	66	74.2
25	19	10	1.33		47	0.23	19	2	1.36		17	0.23		53	1.36		48	0.23	65	73.5
26		55	1.33	42	1	.25		46	1.36		31	.25	19	37	1.36	43	2	.25	64	72.8
27	20	40	1.36		16	.27	20	30	1.36		46	.27	20	21	1.36		17	.27	63	72.0
28	21	24	1.36		32	.27	21	14	1.36	43	2	.27	21	5	1.40		33	.27	62	71.3
29	22	8	1.36		48	.28		58	1.36		18	.28		48	1.40		49	.28	61	70.6
30		52	1.36	43	5	0.28	22	42	1.40		35	0.30	22	31	1.40	44	6	0.28	60	69.8
31	23	36	1.40		22	.32	23	25	1.40		53	.30	23	14	1.40		23	.32	59	69.1
32	24	19	1.40		41	.32	24	8	1.40	44	11	.32		57	1.40		42	.32	58	68.3
33	25	2	1.40	44	0	.33		51	1.40		30	.33	24	40	1.43	45	1	.33	57	67.6
34		45	1.40		20	.33	25	34	1.43		50	.35	25	22	1.43		21	.33	56	66.8
35	26	28	1.40		40	0.37	26	16	1.43	45	11	0.35	26	4	1.43		41	0.37	55	66.0
36	27	11	1.43	45	2	.37		58	1.43		32	.37		46	1.46	46	3	.37	54	65.2
37		53	1.43		24	.38	27	40	1.43		54	.38	27	27	1.46		25	.38	53	64.4
38	28	35	1.43		47	.40	28	22	1.46	46	17	.40	28	8	1.46		48	.40	52	63.6
39	29	17	1.46	46	11	.40	29	3	1.46		41	.42		49	1.46	47	12	.40	51	62.7
40		58	1.46		35	0.43		44	1.46	47	6	0.43	29	30	1.50		36	0.43	50	61.9
41	30	39	1.46	47	1	.45	30	25	1.50		32	.43	30	10	1.50	48	2	.43	49	61.1
42	31	20	1.50		28	.45	31	5	1.50		58	.45		50	1.50		28	.45	48	60.2
43	32	0	1.50		55	.47		45	1.50	48	25	.48	31	30	1.54		55	.48	47	59.3
44		40	1.50	48	23	.48	32	25	1.54		54	.48	32	9	1.54	49	24	.48	46	58.4
45	33	20			52		33	4		49	23			48			53		45	57.5
t	a	60′/Δ		b	Δ/60′		a	60′/Δ		b	Δ/60′		a	60′/Δ		b	Δ/60′			α
	$d = 39° 0'$						$d = 39° 30'$						$d = 40° 0'$							

b / B	a = 39° 0′						a = 39° 30′						a = 40° 0′						c / C	a / β
	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′		
°	°	′		°	′		°	′		°	′		°	′		°	′		°	°
45	33	20	1.54	48	52	0.52	33	4	1.54	49	23	0.50	32	48	1.58	49	53	0.50	45	57.5
46		59	1.54	49	23	.52		43	1.58		53	.52	33	26	1.58	50	23	.52	44	56.6
47	34	38	1.54		54	.53	34	21	1.58	50	24	.53	34	4	1.58		54	.53	43	55.7
48	35	17	1.58	50	26	.55		59	1.58		56	.55		42	1.62	51	26	.55	42	54.8
49		55	1.62		59	.57	35	37	1.62	51	29	.57	35	19	1.62		59	.57	41	53.8
50	36	32	1.62	51	33	0.60	36	14	1.62	52	3	0.60		56	1.67	52	33	0.58	40	52.8
51	37	9	1.62	52	9	.60		51	1.67		39	.60	36	32	1.67	53	8	.60	39	51.9
52		46	1.67		45	.63	37	27	1.67	53	15	.62	37	8	1.71		44	.62	38	50.9
53	38	22	1.71	53	23	.65	38	3	1.71		52	.63		43	1.71	54	21	.63	37	49.8
54		57	1.71	54	2	.65		38	1.76	54	30	.67	38	18	1.76		59	.67	36	48.8
55	39	32	1.71		41	0.68	39	12	1.76	55	10	0.68		52	1.76	55	39	0.67	35	47.7
56	40	7	1.76	55	22	.70		46	1.82		51	.70	39	26	1.82	56	19	.70	34	46.7
57		41	1.82	56	4	.73	40	19	1.82	56	33	.72		59	1.88	57	1	.72	33	45.6
58	41	14	1.88		48	.75		52	1.88	57	16	.73	40	31	1.88		44	.73	32	44.5
59		46	1.88	57	33	.77	41	24	1.88	58	0	.77	41	3	1.94	58	28	.75	31	43.4
60	42	18	1.94	58	19	0.78		56	1.94		46	0.77		34	2.00	59	13	0.77	30	42.2
61		49	1.94	59	6	.80	42	27	2.00	59	32	.80	42	4	2.00		59	.80	29	41.1
62	43	20	2.00		54	.82		57	2.07	60	20	.82		34	2.07	60	47	.80	28	39.9
63		50	2.07	60	43	.85	43	26	2.14	61	9	.85	43	3	2.14	61	35	.83	27	38.7
64	44	19	2.14	61	34	.87		54	2.14	62	0	.85		31	2.22	62	25	.85	26	37.5
65		47	2.22	62	26	0.90	44	22	2.22		51	0.88		58	2.22	63	16	0.87	25	36.2
66	45	14	2.31	63	20	.92		49	2.31	63	44	.90	44	25	2.31	64	8	.90	24	35.0
67		40	2.31	64	15	.93	45	15	2.31	64	38	.93		51	2.40	65	2	.92	23	33.7
68	46	6	2.40	65	11	.95		41	2.50	65	34	.93	45	16	2.50		57	.93	22	32.4
69		31	2.50	66	8	.97	46	5	2.50	66	30	.97		40	2.61	66	53	.95	21	31.1
70		55	2.73	67	6	1.00		29	2.73	67	28	0.98	46	3	2.73	67	50	0.97	20	29.8
71	47	17	2.73	68	6	1.02		51	2.86	68	27	1.00		25	2.86	68	48	.98	19	28.4
72		39	2.86	69	7	1.03	47	12	2.86	69	27	1.02		46	3.00	69	47	1.00	18	27.1
73	48	0	3.00	70	9	1.05		33	3.00	70	28	1.05	47	6	3.00	70	47	1.03	17	25.7
74		20	3.16	71	12	1.07		53	3.33	71	31	1.05		26	3.33	71	49	1.03	16	24.3
75		39	3.33	72	16	1.10	48	11	3.33	72	34	1.08		44	3.53	72	51	1.07	15	22.8
76		57	3.75	73	22	1.12		29	3.75	73	39	1.08	48	1	3.75	73	55	1.08	14	21.4
77	49	13	3.75	74	29	1.12		45	4.00	74	44	1.12		17	4.00	75	0	1.08	13	19.9
78		29	4.29	75	36	1.15	49	0	4.29	75	51	1.12		32	4.29	76	5	1.10	12	18.5
79		43	4.62	76	45	1.15		14	4.62	76	58	1.13		46	5.00	77	11	1.12	11	17.0
80		56	5.00	77	54	1.17		27	5.00	78	6	1.15		58	5.00	78	18	1.13	10	15.5
81	50	8	5.45	79	4	1.18		39	5.45	79	15	1.17	49	10	6.00	79	26	1.15	9	14.0
82		19	6.00	80	15	1.20		50	6.67	80	25	1.17		20	6.67	80	35	1.15	8	12.5
83		29	7.50	81	27	1.20		59	7.50	81	35	1.18		29	7.50	81	44	1.17	7	10.9
84		37	8.57	82	39	1.22	50	7	8.57	82	46	1.20		37	8.57	82	54	1.17	6	9.4
85		44	10.0	83	52	1.22		14	10.0	83	58	1.20		44	10.0	84	4	1.18	5	7.8
86		50	15.0	85	5	1.22		20	15.0	85	10	1.20		50	15.0	85	15	1.18	4	6.3
87		54	20.0	86	18	1.23		24	20.0	86	22	1.20		54	20.0	86	26	1.18	3	4.7
88		57	30.0	87	32	1.23		27	30.0	87	34	1.22		57	30.0	87	37	1.18	2	3.1
89		59	60.0	88	46	1.23		29	60.0	88	47	1.22		59	60.0	88	48	1.20	1	1.6
90	51	0		90	0			30		90	0		50	0		90	0		0	0.0
t	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′		a
	d = 39° 0′						d = 39° 30′						d = 40° 0′							

b / B	a = 40° 30′						a = 41° 0′						a = 41° 30′						c / C	a / β
	h \ d	60′/Δ		Z \ t		Δ/60′	h \ d	60′/Δ		Z \ t		Δ/60′	h \ d	60′/Δ		Z \ t		Δ/60′		
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
0	0 0	1.30		40 30		0.00	0 0	1.33		41 0		0.00	0 0	1.33		41 30		0.00	90	90.0
1	46	1.33		30		.02	45	1.30		0		.02	45	1.33		30		.02	89	89.3
2	1 31	1.30		31		.02	1 31	1.33		1		.02	1 30	1.33		31		.02	88	88.7
3	2 17	1.33		32		.03	2 16	1.33		2		.03	2 15	1.33		32		.03	87	88.0
4	3 2	1.30		34		.03	3 1	1.33		4		.03	3 0	1.33		34		.03	86	87.4
5	48	1.30		36		0.05	46	1.33		6		0.05	45	1.36		36		0.05	85	86.7
6	4 34	1.33		39		.07	4 31	1.30		9		.07	4 29	1.33		39		.07	84	86.1
7	5 19	1.30		43		.07	5 17	1.33		13		.07	5 14	1.33		43		.07	83	85.4
8	6 5	1.33		47		.07	6 2	1.33		17		.07	59	1.33		47		.07	82	84.7
9	50	1.33		51		.08	47	1.33		21		.08	6 44	1.36		51		.08	81	84.1
10	7 35	1.30		56		0.10	7 32	1.33		26		0.10	7 28	1.33		56		0.10	80	83.4
11	8 21	1.33		41 2		.10	8 17	1.33		32		.10	8 13	1.33		42 2		.10	79	82.7
12	9 6	1.33		8		.10	9 2	1.33		38		.10	58	1.36		8		.10	78	82.1
13	51	1.33		14		.12	47	1.36		44		.12	9 42	1.36		14		.12	77	81.4
14	10 36	1.33		21		.13	10 31	1.33		51		.13	10 26	1.33		21		.13	76	80.7
15	11 21	1.33		29		0.13	11 16	1.36		59		0.13	11 11	1.36		29		0.13	75	80.0
16	12 6	1.33		37		.15	12 0	1.33		42 7		.15	55	1.36		37		.15	74	79.3
17	51	1.36		46		.15	45	1.36		16		.17	12 39	1.36		46		.17	73	78.7
18	13 35	1.33		55		.17	13 29	1.36		26		.17	13 23	1.36		56		.17	72	78.0
19	14 20	1.36		42 5		.18	14 13	1.36		36		.17	14 7	1.36		43 6		.18	71	77.3
20	15 4	1.33		16		0.18	57	1.36		46		0.18	51	1.40		17		0.18	70	76.6
21	49	1.36		27		.20	15 41	1.36		57		.20	15 34	1.36		28		.20	69	75.9
22	16 33	1.36		39		.20	16 25	1.36		43 9		.22	16 18	1.40		40		.20	68	75.2
23	17 17	1.36		51		.22	17 9	1.36		22		.22	17 1	1.40		52		.22	67	74.4
24	18 1	1.36		43 4		.23	53	1.40		35		.22	44	1.40		44 5		.23	66	73.7
25	45	1.36		18		0.23	18 36	1.40		48		0.25	18 27	1.40		19		0.23	65	73.0
26	19 29	1.40		32		.25	19 19	1.40		44 3		.25	19 10	1.40		33		.25	64	72.3
27	20 12	1.40		47		.27	20 2	1.40		18		.25	53	1.43		48		.27	63	71.5
28	55	1.40		44 3		.27	45	1.40		33		.27	20 35	1.43		45 4		.27	62	70.8
29	21 38	1.40		19		.28	21 28	1.43		49		.28	21 17	1.43		20		.28	61	70.0
30	22 21	1.40		36		0.30	22 10	1.43		45 6		0.30	59	1.43		37		0.30	60	69.3
31	23 4	1.43		54		.30	52	1.43		24		.32	22 41	1.43		55		.30	59	68.5
32	46	1.43		45 12		.32	23 34	1.43		43		.32	23 23	1.46		46 13		.32	58	67.7
33	24 28	1.43		31		.33	24 16	1.43		46 2		.33	24 4	1.46		32		.33	57	66.9
34	25 10	1.43		51		.35	58	1.46		22		.33	45	1.46		52		.33	56	66.1
35	52	1.46		46 12		0.35	25 39	1.46		42		0.35	25 26	1.46		47 12		0.37	55	65.3
36	26 33	1.46		33		.37	26 20	1.46		47 3		.37	26 7	1.50		34		.37	54	64.5
37	27 14	1.46		55		.38	27 1	1.50		25		.38	47	1.50		56		.38	53	63.7
38	55	1.46		47 18		.40	41	1.50		48		.40	27 27	1.50		48 19		.38	52	62.9
39	28 36	1.50		42		.42	28 21	1.50		48 12		.42	28 7	1.50		42		.42	51	62.0
40	29 16	1.50		48 7		0.42	29 1	1.50		37		0.42	47	1.54		49 7		0.42	50	61.2
41	56	1.54		32		.43	41	1.54		49 2		.43	29 26	1.54		32		.43	49	60.3
42	30 35	1.54		58		.45	30 20	1.54		28		.45	30 5	1.58		58		.45	48	59.4
43	31 14	1.54		49 25		.48	59	1.58		55		.47	43	1.58		50 25		.47	47	58.5
44	53	1.54		54		.48	31 37	1.58		50 23		.48	31 21	1.58		53		.48	46	57.6
45	32 32			50 23			32 15			52			59			51 22			45	56.7
t	a	60′/Δ		b		Δ/60′	a	60′/Δ		b		Δ/60′	a	60′/Δ		b		Δ/60′		a
	d = 40° 30′						d = 41° 0′						d = 41° 30′							

b / B	a = 40° 30′					a = 41° 0′					a = 41° 30′					c / C	a / β
	h \ d		60′/Δ	Z \ t		h \ d		60′/Δ	Z \ t		h \ d		60′/Δ	Z \ t			
					Δ/60′					Δ/60′					Δ/60′		
°	°	′		°	′	°	′		°	′	°	′		°	′	°	°
45	32	32	1.58	50	23	32	15	1.58	50	52	31	59	1.62	51	22	45	56.7
46	33	10	1.62		53		53	1.62	51	22	32	36	1.62		52	44	55.8
47		47	1.62	51	24	33	30	1.62		53	33	13	1.67	52	22	43	54.9
48	34	24	1.62		55	34	7	1.67	52	25		49	1.67		54	42	53.9
49	35	1	1.62	52	28		43	1.67		57	34	25	1.67	53	26	41	53.0
50		38	1.67	53	2	35	19	1.67	53	31	35	1	1.71	54	0	40	52.0
51	36	14	1.71		37		55	1.71	54	6		36	1.76		35	39	51.0
52		49	1.71	54	13	36	30	1.76		42	36	10	1.76	55	10	38	50.0
53	37	24	1.76		50	37	4	1.76	55	18		44	1.76		46	37	49.0
54		58	1.76	55	28		38	1.82		56	37	18	1.82	56	24	36	47.9
55	38	32	1.82	56	7	38	11	1.82	56	35		51	1.88	57	3	35	46.9
56	39	5	1.88		47		44	1.88	57	15	38	23	1.88		42	34	45.8
57		37	1.88	57	28	39	16	1.88		56		55	1.94	58	23	33	44.7
58	40	9	1.94	58	11		48	1.94	58	38	39	26	2.00	59	5	32	43.6
59		40	1.94		54	40	19	2.00	59	21		56	2.00		48	31	42.5
60	41	11	2.00	59	39		49	2.07	60	6	40	26	2.07	60	32	30	41.3
61		41	2.00	60	25	41	18	2.07		51		55	2.07	61	17	29	40.2
62	42	11	2.14	61	12		47	2.14	61	38	41	24	2.14	62	3	28	39.0
63		39	2.14	62	0	42	15	2.14	62	25		52	2.22		50	27	37.8
64	43	7	2.22		50		43	2.31	63	14	42	19	2.31	63	38	26	36.6
65		34	2.31	63	40	43	9	2.31	64	4		45	2.40	64	28	25	35.4
66	44	0	2.40	64	32		35	2.40		55	43	10	2.40	65	19	24	34.2
67		25	2.40	65	25	44	0	2.50	65	48		35	2.50	66	10	23	32.9
68		50	2.50	66	19		24	2.50	66	41		59	2.61	67	3	22	31.6
69	45	14	2.73	67	14		48	2.73	67	36	44	22	2.73		57	21	30.3
70		36	2.73	68	11	45	10	2.73	68	31		44	2.86	68	52	20	29.0
71		58	2.86	69	8		32	3.00	69	28	45	5	3.00	69	48	19	27.7
72	46	19	3.00	70	6		52	3.00	70	26		25	3.00	70	45	18	26.3
73		39	3.16	71	6	46	12	3.33	71	25		45	3.33	71	43	17	25.0
74		58	3.33	72	7		30	3.33	72	25	46	3	3.53	72	42	16	23.6
75	47	16	3.53	73	8		48	3.53	73	25		20	3.53	73	42	15	22.2
76		33	4.00	74	11	47	5	4.00	74	27		37	4.00	74	42	14	20.8
77		48	4.00	75	15		20	4.00	75	30		52	4.29	75	44	13	19.4
78	48	3	4.29	76	19		35	4.62	76	33	47	6	4.62	76	47	12	18.0
79		17	5.00	77	24		48	5.00	77	37		19	5.00	77	50	11	16.5
80		29	5.00	78	30	48	0	5.00	78	42		31	5.45	78	54	10	15.0
81		41	6.00	79	37		12	6.00	79	48		42	6.00	79	58	9	13.6
82		51	6.67	80	45		22	6.67	80	54		52	6.67	81	3	8	12.1
83	49	0	7.50	81	53		31	7.50	82	1	48	1	7.50	82	9	7	10.6
84		8	8.57	83	1		39	10.0	83	9		9	10.0	83	16	6	9.1
85		15	12.0	84	10		45	12.0	84	17		15	12.0	84	23	5	7.6
86		20	15.0	85	20		50	15.0	85	25		20	15.0	85	30	4	6.1
87		24	20.0	86	30		54	20.0	86	33		24	20.0	86	37	3	4.6
88		27	30.0	87	40		57	30.0	87	42		27	30.0	87	44	2	3.0
89		29	60.0	88	50		59	60.0	88	51		29	60.0	88	52	1	1.5
90		30		90	0	49	0		90	0		30		90	0	0	0.0
t	a	60′/Δ	b	Δ/60′		a	60′/Δ	b	Δ/60′		a	60′/Δ	b	Δ/60′		·	a
	d = 40° 30′					d = 41° 0′					d = 41° 30′						

b / B	a = 42° 0′ h	d	60′/Δ	t Z	Δ/60′	a = 42° 30′ h	d	60′/Δ	t Z	Δ/60′	a = 43° 0′ h	d	60′/Δ	t Z	Δ/60′	c / C	a / β
°	° ′			° ′		° ′			° ′		° ′			° ′		°	°
0	0 0	1.33		42 0	0.00	0 0	1.36		42 30	0.00	0 0	1.36		43 0	0.00	90	90.0
1	45	1.36		0	.02	44	1.33		30	.02	44	1.36		0	.02	89	89.3
2	1 29	1.33		1	.02	1 29	1.36		31	.02	1 28	1.36		1	.02	88	88.6
3	2 14	1.36		2	.03	2 13	1.36		32	.03	2 12	1.40		2	.03	87	88.0
4	58	1.33		4	.03	57	1.36		34	.03	55	1.36		4	.03	86	87.3
5	3 43	1.36		6	0.05	3 41	1.36		36	0.05	3 39	1.36		6	0.05	85	86.6
6	4 27	1.33		9	.07	4 25	1.36		39	.07	4 23	1.36		9	.07	84	85.9
7	5 12	1.36		13	.07	5 9	1.36		43	.07	5 7	1.36		13	.07	83	85.3
8	56	1.33		17	.07	53	1.36		47	.07	51	1.40		17	.07	82	84.6
9	6 41	1.36		21	.08	6 37	1.36		51	.08	6 34	1.36		21	.08	81	83.9
10	7 25	1.36		26	0.10	7 21	1.36		56	0.10	7 18	1.40		26	0.10	80	83.2
11	8 9	1.36		32	.10	8 5	1.36		43 2	.10	8 1	1.36		32	.10	79	82.5
12	53	1.36		38	.12	49	1.36		8	.12	45	1.40		38	.12	78	81.8
13	9 37	1.36		45	.12	9 33	1.40		15	.12	9 28	1.40		45	.12	77	81.1
14	10 21	1.36		52	.12	10 16	1.36		22	.13	10 11	1.36		52	.13	76	80.4
15	11 5	1.36		59	0.15	11 0	1.36		30	0.13	55	1.40		44 0	0.13	75	79.7
16	49	1.36		43 8	.15	44	1.40		38	.15	11 38	1.40		8	.15	74	79.0
17	12 33	1.36		17	.15	12 27	1.40		47	.15	12 21	1.40		17	.15	73	78.3
18	13 17	1.40		26	.17	13 10	1.40		56	.17	13 4	1.43		26	.17	72	77.6
19	14 0	1.36		36	.18	53	1.40		44 6	.18	46	1.40		36	.18	71	76.9
20	44	1.40		47	0.18	14 36	1.40		17	0.18	14 29	1.40		47	0.18	70	76.2
21	15 27	1.40		58	.20	15 19	1.40		28	.20	15 12	1.43		58	.20	69	75.5
22	16 10	1.40		44 10	.20	16 2	1.40		40	.20	54	1.43		45 10	.20	68	74.7
23	53	1.40		22	.22	45	1.43		52	.22	16 36	1.43		22	.22	67	74.0
24	17 36	1.40		35	.23	17 27	1.43		45 5	.23	17 18	1.43		35	.23	66	73.3
25	18 19	1.43		49	0.23	18 9	1.43		19	0.23	18 0	1.43		49	0.23	65	72.5
26	19 1	1.43		45 3	.25	51	1.43		33	.25	42	1.43		46 3	.25	64	71.8
27	43	1.43		18	.27	19 33	1.43		48	.27	19 24	1.46		18	.27	63	71.0
28	20 25	1.43		34	.27	20 15	1.43		46 4	.27	20 5	1.46		34	.27	62	70.2
29	21 7	1.43		50	.28	57	1.46		20	.28	46	1.46		50	.28	61	69.5
30	49	1.46		46 7	0.30	21 38	1.46		37	0.30	21 27	1.46		47 7	0.30	60	68.7
31	22 30	1.46		25	.30	22 19	1.46		55	.30	22 8	1.50		25	.30	59	67.9
32	23 11	1.46		43	.32	23 0	1.46		47 13	.32	48	1.50		43	.32	58	67.1
33	52	1.46		47 2	.33	41	1.50		32	.33	23 28	1.50		48 2	.33	57	66.3
34	24 33	1.46		22	.33	24 21	1.50		52	.33	24 8	1.50		22	.33	56	65.5
35	25 14	1.50		42	0.37	25 1	1.50		48 12	0.35	48	1.50		42	0.35	55	64.7
36	54	1.50		48 4	.37	41	1.50		33	.37	25 28	1.54		49 3	.37	54	63.9
37	26 34	1.50		26	.38	26 21	1.54		55	.38	26 7	1.54		25	.38	53	63.0
38	27 14	1.54		49	.38	27 0	1.54		49 18	.40	46	1.58		48	.40	52	62.2
39	53	1.54		49 12	.42	39	1.58		42	.40	27 24	1.58		50 12	.40	51	61.3
40	28 32	1.54		37	0.42	28 17	1.58		50 6	0.42	28 2	1.58		36	0.42	50	60.5
41	29 11	1.58		50 2	.43	55	1.58		31	.43	40	1.58		51 1	.43	49	59.6
42	49	1.58		28	.45	29 33	1.58		57	.45	29 18	1.62		27	.45	48	58.7
43	30 27	1.58		55	.47	30 11	1.62		51 24	.47	55	1.62		54	.45	47	57.8
44	31 5	1.62		51 23	.47	48	1.62		52	.48	30 32	1.62		52 21	.48	46	56.9
45	42			51		31 25			52 21		31 9			50		45	56.0
t	a	60′/Δ		b	Δ/60′	a	60′/Δ		b	Δ/60′	a	60′/Δ		b	Δ/60′		a
	d = 42° 0′					d = 42° 30′					d = 43° 0′						

b / B	a = 42° 0′ h / d	60′/Δ	Z / t	Δ/60′	a = 42° 30′ h / d	60′/Δ	Z / t	Δ/60′	a = 43° 0′ h / d	60′/Δ	Z / t	Δ/60′	c / C	a / β
°	° ′		° ′		° ′		° ′		° ′		° ′		°	°
45	31 42	1.62	51 51	0.50	31 25	1.62	52 21	0.48	31 9	1.67	52 50	0.48	45	56.0
46	32 19	1.67	52 21	.52	32 2	1.67	50	.50	45	1.71	53 19	.50	44	55.0
47	55	1.67	52	.52	38	1.71	53 20	.53	32 20	1.71	49	.52	43	54.1
48	33 31	1.67	53 23	.53	33 13	1.71	52	.53	55	1.71	54 20	.53	42	53.1
49	34 7	1.71	55	.57	48	1.71	54 24	.55	33 30	1.76	52	.55	41	52.1
50	42	1.71	54 29	0.57	34 23	1.76	57	0.57	34 4	1.76	55 25	0.57	40	51.2
51	35 17	1.76	55 3	.58	57	1.76	55 31	.58	38	1.82	59	.58	39	50.2
52	51	1.82	38	.62	35 31	1.82	56 6	.60	35 11	1.82	56 34	.60	38	49.2
53	36 24	1.82	56 15	.62	36 4	1.82	42	.62	44	1.82	57 10	.62	37	48.1
54	57	1.82	52	.63	37	1.88	57 19	.63	36 17	1.94	47	.62	36	47.1
55	37 30	1.88	57 30	0.65	37 9	1.88	57	0.65	48	1.94	58 24	0.65	35	46.0
56	38 2	1.94	58 9	.68	41	1.94	58 36	.68	37 19	1.94	59 3	.67	34	45.0
57	33	1.94	50	.68	38 12	2.00	59 17	.68	50	2.00	43	.68	33	43.9
58	39 4	2.00	59 31	.72	42	2.00	58	.70	38 20	2.07	60 24	.68	32	42.8
59	34	2.00	60 14	.72	39 12	2.07	60 40	.72	49	2.07	61 5	.72	31	41.7
60	40 4	2.07	57	0.75	41	2.14	61 23	0.73	39 18	2.14	48	0.73	30	40.5
61	33	2.14	61 42	.77	40 9	2.14	62 7	.75	46	2.22	62 32	.75	29	39.4
62	41 1	2.22	62 28	.78	37	2.22	52	.78	40 13	2.22	63 17	.75	28	38.2
63	28	2.31	63 15	.78	41 4	2.31	63 39	.78	40	2.31	64 2	.78	27	37.0
64	54	2.31	64 2	.82	30	2.31	64 26	.82	41 6	2.40	49	.80	26	35.8
65	42 20	2.40	51	0.83	56	2.40	65 15	0.82	31	2.50	65 37	0.82	25	34.6
66	45	2.40	65 41	.85	42 21	2.50	66 4	.83	55	2.50	66 26	.83	24	33.4
67	43 10	2.61	66 32	.88	45	2.61	54	.87	42 19	2.61	67 16	.85	23	32.1
68	33	2.61	67 25	.88	43 8	2.73	67 46	.88	42	2.73	68 7	.87	22	30.9
69	56	2.73	68 18	.90	30	2.86	68 39	.88	43 4	2.86	59	.88	21	29.6
70	44 18	2.86	69 12	0.92	51	2.86	69 32	0.90	25	3.00	69 52	0.88	20	28.3
71	39	3.00	70 7	.93	44 12	3.16	70 26	.93	45	3.16	70 45	.92	19	27.0
72	59	3.16	71 3	.97	31	3.16	71 22	.93	44 4	3.33	71 40	.93	18	25.7
73	45 18	3.33	72 1	.97	50	3.33	72 18	.95	22	3.33	72 36	.93	17	24.3
74	36	3.53	59	.98	45 8	3.53	73 15	.98	40	3.53	73 32	.95	16	23.0
75	53	3.75	73 58	1.00	25	4.00	74 14	0.98	57	4.00	74 29	0.97	15	21.6
76	46 9	4.00	74 58	1.00	40	4.00	75 13	1.00	45 12	4.00	75 27	.98	14	20.3
77	24	4.29	75 58	1.03	55	4.29	76 13	1.00	27	4.29	76 26	1.00	13	18.9
78	38	4.62	77 0	1.03	46 9	4.62	77 13	1.02	41	5.00	77 26	1.00	12	17.5
79	51	5.00	78 2	1.05	22	5.00	78 14	1.03	53	5.00	78 26	1.02	11	16.1
80	47 3	6.00	79 5	1.07	34	6.00	79 16	1.05	46 5	6.00	79 27	1.03	10	14.6
81	13	6.00	80 9	1.07	44	6.00	80 19	1.05	15	6.67	80 29	1.03	9	13.2
82	23	6.67	81 13	1.08	54	7.50	81 22	1.07	24	7.50	81 31	1.03	8	11.8
83	32	8.57	82 18	1.08	47 2	7.50	82 26	1.07	32	7.50	82 33	1.05	7	10.3
84	39	8.57	83 23	1.08	10	10.0	83 30	1.07	40	10.0	83 36	1.05	6	8.8
85	46	12.0	84 28	1.10	16	12.0	84 34	1.08	46	12.0	84 39	1.07	5	7.4
86	51	15.0	85 34	1.10	21	15.0	85 39	1.08	51	15.0	85 43	1.07	4	5.9
87	55	20.0	86 40	1.12	25	20.0	86 44	1.08	55	20.0	86 47	1.07	3	4.4
88	58	60.0	87 47	1.10	28	60.0	87 49	1.08	58	60.0	87 51	1.08	2	3.0
89	59	60.0	88 53	1.12	29	60.0	88 54	1.10	59	60.0	88 56	1.07	1	1.5
90	48 0		90 0		30		90 0		47 0		90 0		0	0.0
t	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′		a
	d = 42° 0′				d = 42° 30′				d = 43° 0′					

b / B	a = 43° 30′						a = 44° 0′						a = 44° 30′						c / C	α / β
	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′		
	°	′		°	′		°	′		°	′		°	′		°	′			
0	0	0	1.36	43	30	0.00	0	0	1.40	44	0	0.00	0	0	1.40	44	30	0.00	90	90.0
1		44	1.40		30	.02		43	1.40		0	.02		43	1.40		30	.02	89	89.3
2	1	27	1.36		31	.02	1	26	1.36		1	.02	1	26	1.43		31	.02	88	88.6
3	2	11	1.40		32	.03	2	10	1.40		2	.03	2	8	1.40		32	.03	87	87.9
4		54	1.36		34	.03		53	1.40		4	.03		51	1.40		34	.03	86	87.2
5	3	38	1.40		36	0.05	3	36	1.40		6	0.05	3	34	1.40		36	0.05	85	86.5
6	4	21	1.40		39	.07	4	19	1.40		9	.07	4	17	1.43		39	.07	84	85.8
7	5	4	1.36		43	.07	5	2	1.40		13	.07		59	1.40		43	.07	83	85.1
8		48	1.40		47	.07		45	1.40		17	.07	5	42	1.43		47	.07	82	84.4
9	6	31	1.40		51	.08	6	28	1.40		21	.08	6	24	1.40		51	.08	81	83.7
10	7	14	1.40		56	0.10	7	11	1.43		26	0.10	7	7	1.43		56	0.10	80	83.0
11		57	1.40	44	2	.10		53	1.40		32	.10		49	1.40	45	2	.10	79	82.3
12	8	40	1.40		8	.12	8	36	1.40		38	.12	8	32	1.43		8	.12	78	81.6
13	9	23	1.40		15	.12	9	19	1.43		45	.12	9	14	1.43		15	.12	77	80.9
14	10	6	1.40		22	.13	10	1	1.40		52	.13		56	1.43		22	.13	76	80.2
15		49	1.40		30	0.13		44	1.43	45	0	0.13	10	38	1.43		30	0.13	75	79.5
16	11	32	1.40		38	.15	11	26	1.43		8	.15	11	20	1.43		38	.15	74	78.7
17	12	15	1.43		47	.15	12	8	1.43		17	.15	12	2	1.43		47	.15	73	78.0
18		57	1.40		56	.17		50	1.43		26	.17		44	1.43		56	.17	72	77.3
19	13	40	1.43	45	6	.18	13	32	1.43		36	.18	13	26	1.46	46	6	.18	71	76.5
20	14	22	1.43		17	0.18	14	14	1.43		47	0.18	14	7	1.43		17	0.18	70	75.8
21	15	4	1.43		28	.20		56	1.43		58	.20		49	1.46		28	.20	69	75.1
22		46	1.43		40	.20	15	38	1.46	46	10	.20	15	30	1.46		40	.20	68	74.3
23	16	28	1.43		52	.22	16	19	1.43		22	.22	16	11	1.46		52	.22	67	73.6
24	17	10	1.46	46	5	.23	17	1	1.46		35	.23		52	1.46	47	5	.23	66	72.8
25		51	1.46		19	0.23		42	1.46		49	0.23	17	33	1.50		19	0.23	65	72.1
26	18	32	1.46		33	.25	18	23	1.46	47	3	.25	18	13	1.46		33	.25	64	71.3
27	19	13	1.46		48	.27	19	4	1.50		18	.27		54	1.50		48	.27	63	70.5
28		54	1.46	47	4	.27		44	1.46		34	.27	19	34	1.50	48	4	.27	62	69.7
29	20	35	1.46		20	.28	20	25	1.50		50	.28	20	14	1.50		20	.28	61	68.9
30	21	16	1.50		37	0.30	21	5	1.50	48	7	0.30		54	1.54		37	0.28	60	68.1
31		56	1.50		55	.30		45	1.50		25	.30	21	33	1.54		54	.30	59	67.3
32	22	36	1.50	48	13	.32	22	25	1.54		43	.32	22	12	1.54	49	12	.32	58	66.5
33	23	16	1.50		32	.33	23	4	1.54	49	2	.32		51	1.54		31	.33	57	65.7
34		56	1.54		52	.33		43	1.54		21	.35	23	30	1.54		51	.33	56	64.9
35	24	35	1.54	49	12	0.35	24	22	1.54		42	0.35	24	9	1.58	50	11	0.35	55	64.1
36	25	14	1.54		33	.37	25	1	1.58	50	3	.37		47	1.58		32	.37	54	63.2
37		53	1.54		55	.38		39	1.58		25	.37	25	25	1.58		54	.38	53	62.4
38	26	32	1.58	50	18	.38	26	17	1.58		47	.40	26	3	1.62	51	17	.38	52	61.5
39	27	10	1.58		41	.40		55	1.62	51	11	.40		40	1.62		40	.40	51	60.6
40		48	1.62	51	5	0.42	27	32	1.62		35	0.42	27	17	1.62	52	4	0.42	50	59.8
41	28	25	1.62		30	.43	28	9	1.62	52	0	.42		54	1.67		29	.42	49	58.9
42	29	2	1.62		56	.45		46	1.62		25	.45	28	30	1.67		54	.45	48	58.0
43		39	1.67	52	23	.45	29	23	1.67		52	.45	29	6	1.67	53	21	.45	47	57.1
44	30	15	1.67		50	.48		59	1.71	53	19	.47		42	1.71		48	.47	46	56.1
45		51		53	19		30	34			47		30	17		54	16		45	55.2
t	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′		α
	d = 43° 30′						d = 44° 0′						d = 44° 30′							

b / B	$a = 43° 30'$						$a = 44° 0'$						$a = 44° 30'$						c / C	a / β
	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′		
°	°	′		°	′		°	′		°	′		°	′		°	′		°	°
45	30	51	1.67	53	19	0.48	30	34	1.67	53	47	0.48	30	17	1.71	54	16	0.48	45	55.2
46	31	27	1.71		48	.50	31	10	1.71	54	16	.50		52	1.76		45	.48	44	54.3
47	32	2	1.71	54	18	.52		45	1.76		46	.52	31	26	1.76	55	14	.52	43	53.3
48		37	1.76		49	.53	32	19	1.76	55	17	.53	32	0	1.76		45	.52	42	52.4
49	33	11	1.76	55	21	.53		53	1.82		49	.53		34	1.82	56	16	.55	41	51.4
50		45	1.76		53	0.57	33	26	1.82	56	21	0.57	33	7	1.82		49	0.55	40	50.4
51	34	19	1.82	56	27	.58		59	1.82		55	.57		40	1.88	57	22	.57	39	49.4
52		52	1.88	57	2	.58	34	32	1.88	57	29	.58	34	12	1.88		56	.58	38	48.4
53	35	24	1.88		37	.60	35	4	1.94	58	4	.60		44	1.94	58	31	.60	37	47.3
54		56	1.94	58	13	.63		35	1.94		40	.62	35	15	2.00	59	7	.62	36	46.3
55	36	27	1.94		51	0.65	36	6	2.00	59	17	0.65		45	2.00		44	0.62	35	45.2
56		58	2.00	59	30	.65		36	2.00		56	.65	36	15	2.07	60	21	.65	34	44.2
57	37	28	2.00	60	9	.67	37	6	2.07	60	35	.67		44	2.07	61	0	.67	33	43.1
58		58	2.07		49	.70		35	2.07	61	15	.68	37	13	2.14		40	.68	32	42.0
59	38	27	2.14	61	31	.70	38	4	2.14		56	.70		41	2.14	62	21	.68	31	40.9
60		55	2.14	62	13	0.72		32	2.22	62	38	0.72	38	9	2.22	63	2	0.70	30	39.7
61	39	23	2.22		56	.75		59	2.22	63	21	.72		36	2.31		44	.73	29	38.6
62		50	2.31	63	41	.75	39	26	2.31	64	4	.75	39	2	2.40	64	28	.73	28	37.4
63	40	16	2.40	64	26	.77		52	2.40		49	.77		27	2.40	65	12	.75	27	36.3
64		41	2.40	65	12	.80	40	17	2.50	65	35	.78		52	2.50		57	.78	26	35.1
65	41	6	2.50	66	0	0.80		41	2.50	66	22	0.80	40	16	2.50	66	44	0.78	25	33.9
66		30	2.61		48	.82	41	5	2.61	67	10	.80		40	2.73	67	31	.80	24	32.7
67		53	2.61	67	37	.85		28	2.73		58	.83	41	2	2.73	68	19	.82	23	31.4
68	42	16	2.86	68	28	.85		50	2.86	68	48	.83		24	2.86	69	8	.83	22	30.2
69		37	2.86	69	19	.87	42	11	3.00	69	38	.87		45	3.00		58	.85	21	28.9
70		58	3.00	70	11	0.88		31	3.00	70	30	0.87	42	5	3.16	70	49	0.85	20	27.7
71	43	18	3.16	71	4	.90		51	3.16	71	22	.88		24	3.16	71	40	.88	19	26.4
72		37	3.33		58	.92	43	10	3.33	72	15	.90		43	3.53	72	33	.88	18	25.1
73		55	3.33	72	53	.92		28	3.53	73	9	.92	43	0	3.53	73	26	.90	17	23.8
74	44	13	3.75	73	48	.95		45	3.75	74	4	.93		17	3.75	74	20	.92	16	22.4
75		29	4.00	74	45	0.95	44	1	4.00	75	0	0.93		33	4.00	75	15	0.92	15	21.1
76		44	4.29	75	42	.97		16	4.29		56	.95		48	4.62	76	10	.93	14	19.7
77		58	4.29	76	40	.98		30	4.62	76	53	.97	44	1	4.62	77	6	.95	13	18.4
78	45	12	5.00	77	39	.98		43	5.00	77	51	.97		14	5.00	78	3	.97	12	17.0
79		24	5.45	78	38	1.00		55	5.45	78	49	.98		26	5.45	79	1	.97	11	15.6
80		35	5.45	79	38	1.00	45	6	6.00	79	48	1.00		37	6.00		59	0.97	10	14.2
81		46	6.67	80	38	1.02		16	6.00	80	48	1.00		47	6.67	80	57	.98	9	12.8
82		55	7.50	81	39	1.03		26	7.50	81	48	1.00		56	7.50	81	56	1.00	8	11.4
83	46	3	8.57	82	41	1.03		34	8.57	82	48	1.02	45	4	8.57	82	56	1.00	7	10.0
84		10	10.0	83	43	1.03		41	10.0	83	49	1.02		11	10.0	83	56	1.00	6	8.6
85		16	12.0	84	45	1.05		47	15.0	84	50	1.03		17	15.0	84	56	1.00	5	7.2
86		21	15.0	85	48	1.05		51	15.0	85	52	1.03		21	15.0	85	56	1.02	4	5.7
87		25	20.0	86	51	1.05		55	20.0	86	54	1.03		25	20.0	86	57	1.02	3	4.3
88		28	60.0	87	54	1.05		58	60.0	87	56	1.03		28	60.0	87	58	1.02	2	2.9
89		29	60.0	88	57	1.05		59	60.0	88	58	1.03		29	60.0	88	59	1.02	1	1.4
90		30		90	0		46	0		90	0			30		90	0		0	0.0

t	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′		a
	$d = 43° 30'$				$d = 44° 0'$				$d = 44° 30'$					

b / B	a = 45° 0′						a = 45° 30′						a = 46° 0′						c / C	a / β
	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′		
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
0	0 0		1.43	45 0		0.00	0 0		1.43	45 30		0.00	0 0		1.43	46 0		0.00	90	90.0
1		42	1.40		0	.02		42	1.43		30	.02		42	1.46		0	.02	89	89.3
2	1 25		1.43		1	.02	1 24		1.43		31	.02	1 23		1.43		1	.02	88	88.6
3	2 7		1.40		2	.03	2 6		1.43		32	.03	2 5		1.43		2	.03	87	87.9
4		50	1.43		4	.03		48	1.43		34	.03		47	1.46		4	.03	86	87.1
5	3 32		1.43		6	0.05	3 30		1.43		36	0.05	3 28		1.43		6	0.05	85	86.4
6	4 14		1.40		9	.07	4 12		1.43		39	.07	4 10		1.46		9	.07	84	85.7
7		57	1.43		13	.07		54	1.43		43	.07		51	1.43		13	.07	83	85.0
8	5 39		1.43		17	.07	5 36		1.43		47	.07	5 33		1.46		17	.07	82	84.3
9	6 21		1.43		21	.08	6 18		1.43		51	.08	6 14		1.43		21	.08	81	83.6
10	7 3		1.43		26	0.10	7 0		1.46		56	0.10		56	1.46		26	0.10	80	82.8
11		45	1.43		32	.10		41	1.43	46 2		.10	7 37		1.46		32	.10	79	82.1
12	8 27		1.43		38	.12	8 23		1.46		8	.12	8 18		1.46		38	.12	78	81.4
13	9 9		1.43		45	.12	9 4		1.43		15	.12		59	1.46		45	.12	77	80.7
14		51	1.43		52	.13		46	1.46		22	.13	9 40		1.46		52	.13	76	79.9
15	10 33		1.43	46 0		0.13	10 27		1.46		30	0.13	10 21		1.46	47 0		0.13	75	79.2
16	11 15		1.46		8	.15	11 8		1.46		38	.15	11 2		1.46		8	.15	74	78.4
17		56	1.46		17	.15		49	1.46		47	.15		43	1.46		17	.15	73	77.7
18	12 37		1.46		26	.17	12 30		1.46		56	.17	12 24		1.50		26	.17	72	77.0
19	13 18		1.46		36	.18	13 11		1.46	47 6		.18	13 4		1.46		36	.18	71	76.2
20		59	1.46		47	0.18		52	1.46		17	0.18		45	1.50		47	0.18	70	75.4
21	14 40		1.46		58	.20	14 33		1.50		28	.20	14 25		1.50		58	.20	69	74.7
22	15 21		1.46	47 10		.20	15 13		1.46		40	.20	15 5		1.50	48 10		.20	68	73.9
23	16 2		1.46		22	.22		54	1.50		52	.22		45	1.50		22	.22	67	73.2
24		43	1.50		35	.23	16 34		1.50	48 5		.23	16 25		1.50		35	.23	66	72.4
25	17 23		1.50		49	0.23	17 14		1.50		19	0.23	17 5		1.54		49	0.23	65	71.6
26	18 3		1.50	48 3		.25		54	1.54		33	.25		44	1.54	49 3		.23	64	70.8
27		43	1.50		18	.25	18 33		1.50		48	.25	18 23		1.54		17	.27	63	70.0
28	19 23		1.50		33	.27	19 13		1.54	49 3		.27	19 2		1.54		33	.27	62	69.2
29	20 3		1.54		49	.28		52	1.54		19	.28		41	1.54		49	.28	61	68.4
30		42	1.54	49 6		0.30	20 31		1.54		36	0.30	20 20		1.58	50 6		0.28	60	67.6
31	21 21		1.54		24	.30	21 10		1.58		54	.30		58	1.58		23	.30	59	66.8
32	22 0		1.54		42	.32		48	1.58	50 12		.30	21 36		1.58		41	.32	58	66.0
33		39	1.54	50 1		.32	22 26		1.58		30	.33	22 14		1.58	51 0		.32	57	65.1
34	23 18		1.58		20	.35	23 4		1.58		50	.33		52	1.62		19	.33	56	64.3
35		56	1.58		41	0.35		42	1.58	51 10		0.35	23 29		1.62		39	0.35	55	63.5
36	24 34		1.62	51 2		.35	24 20		1.62		31	.37	24 6		1.62	52 0		.37	54	62.6
37	25 11		1.62		23	.38		57	1.62		53	.37		43	1.67		22	.37	53	61.7
38		48	1.62		46	.38	25 34		1.62	52 15		.38	25 19		1.67		44	.38	52	60.9
39	26 25		1.62	52 9		.40	26 11		1.67		38	.40		55	1.67	53 7		.40	51	60.0
40	27 2		1.67		33	0.42		47	1.67	53 2		0.40	26 31		1.67		31	0.40	50	59.1
41		38	1.67		58	.42	27 23		1.71		26	.43	27 7		1.71		55	.42	49	58.2
42	28 14		1.67	53 23		.43		58	1.71		52	.43		42	1.71	54 20		.43	48	57.3
43		50	1.71		49	.45	28 33		1.71	54 18		.45	28 17		1.76		46	.45	47	56.4
44	29 25		1.71	54 16		.47	29 8		1.71		45	.45		51	1.76	55 13		.45	46	55.4
45	30 0				44			43		55 12			29 25				40		45	54.5
t	a	60′/Δ	b			Δ/60′	a	60′/Δ	b			Δ/60′	a	60′/Δ	b			Δ/60′		a
	d = 45° 0′						d = 45° 30′						d = 46° 0′							

b / B	a = 45° 0′						a = 45° 30′						a = 46° 0′						c / C	a / β
	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′		
°	°	′		°	′		°	′		°	′		°	′		°	′		°	°
45	30	0	1.76	54	44	0.48	29	43	1.76	55	12	0.48	29	25	1.76	55	40	0.48	45	54.5
46		34	1.76	55	13	.48	30	17	1.82		41	.48		59	1.82	56	9	.48	44	53.6
47	31	8	1.76		42	.52		50	1.82	56	10	.50	30	32	1.82		38	.50	43	52.6
48		42	1.82	56	13	.52	31	23	1.82		40	.52	31	5	1.88	57	8	.52	42	51.6
49	32	15	1.82		44	.53		56	1.88	57	11	.53		37	1.88		39	.52	41	50.6
50		48	1.88	57	16	0.55	32	28	1.88		43	0.55	32	9	1.94	58	10	0.55	40	49.6
51	33	20	1.88		49	.57	33	0	1.88	58	16	.57		40	1.94		43	.55	39	48.6
52		52	1.94	58	23	.58		32	1.94		50	.57	33	11	1.94	59	16	.57	38	47.6
53	34	23	1.94		58	.58	34	3	2.00	59	24	.58		42	2.00		50	.58	37	46.6
54		54	2.00	59	33	.62		33	2.00		59	.62	34	12	2.07	60	25	.60	36	45.5
55	35	24	2.07	60	10	0.62	35	3	2.07	60	36	0.62		41	2.07	61	1	0.62	35	44.5
56		53	2.07		47	.65		32	2.14	61	13	.63	35	10	2.14		38	.62	34	43.4
57	36	22	2.07	61	26	.65	36	0	2.14		51	.65		38	2.14	62	15	.65	33	42.3
58		51	2.14	62	5	.67		28	2.14	62	30	.65	36	6	2.22		54	.65	32	41.2
59	37	19	2.22		45	.68		56	2.22	63	9	.68		33	2.31	63	33	.68	31	40.1
60		46	2.31	63	26	0.70	37	23	2.31		50	0.70		59	2.31	64	14	0.68	30	39.0
61	38	12	2.31	64	8	.72		49	2.40	64	32	.70	37	25	2.40		55	.70	29	37.9
62		38	2.40		51	.73	38	14	2.40	65	14	.72		50	2.50	65	37	.72	28	36.7
63	39	3	2.50	65	35	.75		39	2.50		57	.75	38	14	2.50	66	20	.72	27	35.5
64		27	2.50	66	20	.75	39	3	2.61	66	42	.75		38	2.61	67	3	.75	26	34.4
65		51	2.61	67	5	0.78		26	2.61	67	27	0.77	39	1	2.73		48	0.75	25	33.2
66	40	14	2.73		52	.80		49	2.73	68	13	.78		23	2.73	68	33	.78	24	32.0
67		36	2.73	68	40	.80	40	11	2.86	69	0	.80		45	2.86	69	20	.78	23	30.8
68		58	2.86	69	28	.82		32	3.00		48	.80	40	6	3.00	70	7	.80	22	29.5
69	41	19	3.00	70	17	.83		52	3.00	70	36	.82		26	3.16		55	.80	21	28.3
70		39	3.16	71	7	0.85	41	12	3.33	71	25	0.83		45	3.33	71	43	0.83	20	27.0
71		58	3.33		58	.87		30	3.33	72	15	.85	41	3	3.33	72	33	.83	19	25.8
72	42	16	3.53	72	50	.87		48	3.53	73	6	.87		21	3.53	73	23	.85	18	24.5
73		33	3.75	73	42	.88	42	5	3.75		58	.88		38	3.75	74	14	.87	17	23.2
74		49	3.75	74	35	.90		21	3.75	74	51	.88		54	4.00	75	6	.87	16	21.9
75	43	5	4.29	75	29	0.92		37	4.29	75	44	0.90	42	9	4.29		58	0.88	15	20.6
76		19	4.29	76	24	.92		51	4.29	76	38	.90		23	4.62	76	51	.90	14	19.3
77		33	4.62	77	19	.93	43	5	5.00	77	32	.92		36	5.00	77	45	.90	13	17.9
78		46	5.45	78	15	.95		17	5.00	78	27	.93		48	5.00	78	39	.92	12	16.6
79		57	5.45	79	12	.95		29	6.00	79	23	.93	43	0	6.00	79	34	.92	11	15.2
80	44	8	6.00	80	9	0.97		39	6.00	80	19	0.95		10	6.00	80	29	0.93	10	13.9
81		18	6.67	81	7	.97		49	7.50	81	16	.95		20	7.50	81	25	.93	9	12.5
82		27	8.57	82	5	.97		57	7.50	82	13	.95		28	8.57	82	21	.93	8	11.2
83		34	8.57	83	3	.98	44	5	8.57	83	10	.97		35	8.57	83	17	.95	7	9.8
84		41	10.0	84	2	.98		12	12.0	84	8	.97		42	12.0	84	14	.95	6	8.4
85		47	12.0	85	1	0.98		17	12.0	85	6	0.98		47	12.0	85	11	0.97	5	7.0
86		52	20.0	86	0	1.00		22	20.0	86	5	.97		52	20.0	86	9	.95	4	5.6
87		55	20.0	87	0	1.00		25	20.0	87	3	.98		55	20.0	87	6	.97	3	4.2
88		58	60.0	88	0	1.00		28	60.0	88	2	.98		58	60.0	88	4	.97	2	2.8
89		59	60.0	89	0	1.00		29	60.0	89	1	.98		59	60.0	89	2	.97	1	1.4
90	45	0		90	0			30		90	0		44	0		90	0		0	0.0

t	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′		a
	d = 45° 0′				d = 45° 30′				d = 46° 0′					

b / B	a = 46° 30′						a = 47° 0′						a = 47° 30′						c / C	α / β
	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′		
°	°	′		°	′		°	′		°	′		°	′		°	′		°	°
0	0	0	1.46	46	30	0.00	0	0	1.46	47	0	0.00	0	0	1.46	47	30	0.00	90	90.0
1		41	1.43		30	.02		41	1.46		0	.02		41	1.50		30	.02	89	89.3
2	1	23	1.46		31	.02	1	22	1.46		1	.02	1	21	1.46		31	.02	88	88.5
3	2	4	1.46		32	.03	2	3	1.46		2	.03	2	2	1.50		32	.03	87	87.8
4		45	1.46		34	.03		44	1.46		4	.03		42	1.46		34	.03	86	87.1
5	3	26	1.43		36	0.05	3	25	1.50		6	0.05	3	23	1.50		36	0.05	85	86.3
6	4	8	1.46		39	.07	4	5	1.46		9	.07	4	3	1.50		39	.07	84	85.6
7		49	1.46		43	.07		46	1.46		13	.07		43	1.46		43	.07	83	84.9
8	5	30	1.46		47	.07	5	27	1.50		17	.07	5	24	1.50		47	.07	82	84.1
9	6	11	1.46		51	.08	6	7	1.46		21	.08	6	4	1.50		51	.08	81	83.4
10		52	1.46		56	0.10		48	1.46		26	0.10		44	1.50		56	0.10	80	82.7
11	7	33	1.46	47	2	.10	7	29	1.50		32	.10	7	24	1.50	48	2	.10	79	81.9
12	8	14	1.46		8	.12	8	9	1.50		38	.12	8	4	1.50		8	.10	78	81.2
13		55	1.50		15	.12		49	1.46		45	.12		44	1.50		14	.12	77	80.4
14	9	35	1.46		22	.13	9	30	1.50		52	.13	9	24	1.50		21	.13	76	79.7
15	10	16	1.50		30	0.13	10	10	1.50	48	0	0.13	10	4	1.50		29	0.13	75	78.9
16		56	1.46		38	.15		50	1.50		8	.15		44	1.50		37	.15	74	78.2
17	11	37	1.50		47	.15	11	30	1.50		17	.15	11	24	1.54		46	.17	73	77.4
18	12	17	1.50		56	.17	12	10	1.50		26	.17	12	3	1.50		56	.17	72	76.6
19		57	1.50	48	6	.18		50	1.54		36	.17		43	1.54	49	6	.17	71	75.9
20	13	37	1.50		17	0.18	13	29	1.50		46	0.18	13	22	1.54		16	0.18	70	75.1
21	14	17	1.50		28	.20	14	9	1.54		57	.20	14	1	1.54		27	.20	69	74.3
22		57	1.54		40	.20		48	1.54	49	9	.20		40	1.54		39	.20	68	73.5
23	15	36	1.50		52	.22	15	27	1.54		21	.22	15	19	1.58		51	.22	67	72.8
24	16	16	1.54	49	5	22	16	6	1.54		34	.23		57	1.58	50	4	.23	66	72.0
25		55	1.54		18	0.23		45	1.54		48	0.23	16	35	1.58		18	0.23	65	71.2
26	17	34	1.54		32	.25	17	24	1.58	50	2	.25	17	13	1.58		32	.23	64	70.4
27	18	13	1.58		47	.25	18	2	1.58		17	.25		51	1.58		46	.25	63	69.6
28		51	1.54	50	2	.27		40	1.58		32	.27	18	29	1.58	51	1	.27	62	68.8
29	19	30	1.58		18	.28	19	18	1.58		48	.28	19	7	1.58		17	.28	61	67.9
30	20	8	1.58		35	0.28		56	1.58	51	5	0.28		45	1.62		34	0.28	60	67.1
31		46	1.58		52	.30	20	34	1.62		22	.30	20	22	1.62		51	.30	59	66.3
32	21	24	1.62	51	10	.32	21	11	1.62		40	.30		59	1.62	52	9	.32	58	65.4
33	22	1	1.62		29	.32		48	1.62		58	.32	21	36	1.67		28	.32	57	64.6
34		38	1.62		48	.33	22	25	1.62	52	17	.33	22	12	1.67		47	.33	56	63.7
35	23	15	1.62	52	8	0.35	23	2	1.67		37	0.35		48	1.67	53	7	0.33	55	62.9
36		52	1.67		29	.37		38	1.67		58	.35	23	24	1.67		27	.35	54	62.0
37	24	28	1.67		51	.37	24	14	1.67	53	19	.37	24	0	1.71		48	.37	53	61.1
38	25	4	1.67	53	13	.38		50	1.71		41	.38		35	1.71	54	10	.38	52	60.3
39		40	1.67		36	.38	25	25	1.71	54	4	.40	25	10	1.76		33	.38	51	59.4
40	26	16	1.71		59	0.40	26	0	1.71		28	0.40		44	1.76		56	0.40	50	58.5
41		51	1.71	54	23	.42		35	1.76		52	.42	26	18	1.76	55	20	.42	49	57.6
42	27	26	1.76		48	.43	27	9	1.76	55	17	.42		52	1.76		45	.42	48	56.6
43	28	0	1.76	55	14	.45		43	1.76		42	.45	27	26	1.82	56	10	.43	47	55.7
44		34	1.76		41	.45	28	17	1.82	56	9	.45		59	1.82		36	.45	46	54.8
45	29	8		56	8			50			36		28	32		57	3		45	53.8
t	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′								α
	d = 46° 30′				d = 47° 0′				d = 47° 30′											

b / B	a = 46° 30′						a = 47° 0′						a = 47° 30′						c / C	a / αβ
	d / h	60′/Δ		t / Z	Δ/60′		d / h	60′/Δ		t / Z	Δ/60′		d / h	60′/Δ		t / Z	Δ/60′			
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
45	29 8	1.82		56 8	0.47		28 50	1.82		56 36	0.47		28 32	1.82		57 3	0.47		45	53.8
46	41	1.82		36	.48		29 23	1.88		57 4	.48		29 5	1.88		31	.48		44	52.9
47	30 14	1.88		57 5	.50		55	1.88		33	.48		37	1.94		58 0	.48		43	51.9
48	46	1.88		35	.52		30 27	1.88		58 2	.52		30 8	1.94		29	.50		42	50.9
49	31 18	1.94		58 6	.52		59	1.94		33	.52		39	1.94		59	.52		41	49.9
50	49	1.94		37	0.53		31 30	2.00		59 4	0.53		31 10	2.00		59 30	0.53		40	48.9
51	32 20	1.94		59 9	.55		32 0	2.00		36	.53		40	2.00		60 2	.53		39	47.9
52	51	2.00		42	.57		30	2.00		60 8	.57		32 10	2.07		34	.55		38	46.9
53	33 21	2.07		60 16	.58		33 0	2.07		42	.57		39	2.07		61 7	.57		37	45.9
54	50	2.07		51	.58		29	2.07		61 16	.60		33 8	2.14		41	.58		36	44.8
55	34 19	2.07		61 26	0.62		58	2.14		52	0.60		36	2.14		62 16	0.60		35	43.8
56	48	2.14		62 3	.62		34 26	2.22		62 28	.60		34 4	2.22		52	.62		34	42.7
57	35 16	2.22		40	.63		53	2.22		63 4	.63		31	2.31		63 29	.62		33	41.6
58	43	2.22		63 18	.65		35 20	2.31		42	.65		57	2.31		64 6	.63		32	40.5
59	36 10	2.31		57	.67		46	2.31		64 21	.65		35 23	2.40		44	.65		31	39.4
60	36	2.40		64 37	0.68		36 12	2.40		65 0	0.67		48	2.40		65 23	0.67		30	38.3
01	37 1	2.40		65 18	.68		37	2.50		40	.68		36 13	2.50		66 3	.67		29	37.2
62	26	2.50		59	.70		37 1	2.50		66 21	.70		37	2.61		43	.70		28	36.0
63	50	2.61		66 41	.73		25	2.61		67 3	.72		37 0	2.61		67 25	.70		27	34.9
64	38 13	2.61		67 25	.73		48	2.73		46	.73		23	2.73		68 7	.72		26	33.7
65	36	2.73		68 9	0.75		38 10	2.73		68 30	0.73		45	2.86		50	0.73		25	32.5
66	58	2.86		54	.75		32	2.86		69 14	.75		38 6	2.86		69 34	.73		24	31.3
67	39 19	3.00		69 39	.78		53	3.00		59	.77		27	3.00		70 18	.75		23	30.1
68	39	3.00		70 26	.78		39 13	3.00		70 45	.77		47	3.16		71 3	.77		22	28.9
69	59	3.16		71 13	.80		33	3.33		71 31	.80		39 6	3.33		49	.78		21	27.7
70	40 18	3.33		72 1	0.82		51	3.33		72 19	0.80		24	3.33		72 36	0.78		20	26.5
71	36	3.53		50	.82		40 9	3.53		73 7	.82		42	3.53		73 23	.80		19	25.2
72	53	3.53		73 39	.83		26	3.75		56	.82		59	3.75		74 11	.82		18	24.0
73	41 10	3.75		74 29	.85		42	3.75		74 45	.83		40 15	4.00		75 0	.82		17	22.7
74	26	4.29		75 20	.87		58	4.29		75 35	.85		30	4.29		49	.83		16	21.4
75	40	4.29		76 12	0.87		41 12	4.29		76 26	0.85		44	4.29		76 39	0.85		15	20.1
76	54	4.62		77 4	.88		26	4.62		77 17	.87		58	5.00		77 30	.85		14	18.8
77	42 7	5.00		57	.88		39	5.00		78 9	.88		41 10	5.00		78 21	.87		13	17.5
78	19	5.00		78 50	.90		51	5.45		79 2	.88		22	5.45		79 13	.87		12	16.2
79	31	6.00		79 44	.90		42 2	6.00		55	.88		33	6.00		80 5	.88		11	14.9
80	41	6.67		80 38	0.92		12	6.67		80 48	0.90		43	6.67		58	0.88		10	13.6
81	50	7.50		81 33	.93		21	7.50		81 42	.90		52	7.50		81 51	.88		9	12.2
82	58	7.50		82 29	.92		29	8.57		82 36	.92		42 0	8.75		82 44	.90		8	10.9
83	43 6	10.0		83 24	.93		36	10.0		83 31	.92		7	10.0		83 38	.90		7	9.5
84	12	10.0		84 20	.93		42	10.0		84 26	.92		13	12.0		84 32	.90		6	8.2
85	18	15.0		85 16	0.95		48	15.0		85 21	0.93		18	15.0		85 26	0.90		5	6.8
86	22	15.0		86 13	.93		52	15.0		86 17	.92		22	15.0		86 20	.92		4	5.5
87	26	30.0		87 9	.95		56	30.0		87 12	.93		26	30.0		87 15	.92		3	4.1
88	28	30.0		88 6	.95		58	30.0		88 8	.93		28	30.0		88 10	.92		2	2.7
89	30	—		89 3	.95		43 0	—		89 4	.93		30	—		89 5	.92		1	1.4
90	30			90 0			0			90 0			30			90 0			0	0.0

t	a	60′/Δ	b	Δ/60′	a	b	Δ/60′	a	60′/Δ	b	Δ/60′	a
	d = 46° 30′				d = 47° 0′			d = 47° 30′				

	0.900					0.885					0.869					
b / B	$a = 48° 0'$					$a = 48° 30'$					$a = 49° 0'$					c / a
	h \ d	60′/Δ		Z \ t	Δ/60′	h \ d	60′/Δ		Z \ t	Δ/60′	h \ d	60′/Δ		Z \ t	Δ/60′	C / β
°	° ′			° ′		° ′			° ′		° ′			° ′		° / ° ′
0	0 0	1.50		48 0	0.00	0 0	1.50		48 30	0.00	0 0	1.54		49 0	0.00	90 / 90.0
1	40	1.50		0	.02	40	1.50		30	.02	39	1.50		0	.02	89 / 89.3
2	1 20	1.50		1	.02	1 20	1.54		31	.02	1 19	1.54		1	.02	88 / 88.5
3	2 0	1.50		2	.03	59	1.50		32	.03	58	1.54		2	.03	87 / 87.8
4	40	1.50		4	.03	2 39	1.50		34	.03	2 37	1.50		4	.03	86 / 87.0
5	3 20	1.50		6	0.05	3 19	1.54		36	0.05	3 17	1.54		6	0.05	85 / 86.3
6	4 0	1.50		9	.07	58	1.50		39	.07	56	1.54		9	.07	84 / 85.5
7	40	1.50		13	.07	4 38	1.54		43	.07	4 35	1.54		13	.07	83 / 84.7
8	5 20	1.50		17	.07	5 17	1.50		47	.07	5 14	1.54		17	.07	82 / 84.0
9	6 0	1.50		21	.08	57	1.54		51	.08	53	1.54		21	.08	81 / 83.2
10	40	1.50		26	0.10	6 36	1.50		56	0.10	6 32	1.54		26	0.10	80 / 82.5
11	7 20	1.50		32	.10	7 16	1.54		49 2	.10	7 11	1.54		32	.10	79 / 81.7
12	8 0	1.54		38	.10	55	1.54		8	.10	50	1.54		38	.10	78 / 81.0
13	39	1.50		44	.12	8 34	1.54		14	.12	8 29	1.54		44	.12	77 / 80.2
14	9 19	1.54		51	.13	9 13	1.54		21	.13	9 8	1.54		51	.13	76 / 79.4
15	58	1.50		59	0.13	52	1.54		29	0.13	47	1.58		59	0.13	75 / 78.7
16	10 38	1.54		49 7	.15	10 31	1.54		37	.15	10 25	1.54		50 7	.15	74 / 77.9
17	11 17	1.54		16	.15	11 10	1.54		46	.15	11 4	1.58		16	.15	73 / 77.1
18	56	1.54		25	.17	49	1.54		55	.17	42	1.58		25	.17	72 / 76.3
19	12 35	1.54		35	.18	12 28	1.58		50 5	.18	12 20	1.58		35	.17	71 / 75.5
20	13 14	1.54		46	0.18	13 6	1.58		16	0.18	58	1.58		45	0.18	70 / 74.8
21	53	1.58		57	.20	44	1.58		27	.18	13 36	1.58		56	.20	69 / 74.0
22	14 31	1.58		50 9	.20	14 22	1.58		38	.20	14 14	1.62		51 8	.20	68 / 73.2
23	15 9	1.58		21	.22	15 0	1.58		50	.22	51	1.58		20	.22	67 / 72.4
24	47	1.58		34	.22	38	1.58		51 3	.23	15 29	1.62		33	.22	66 / 71.6
25	16 25	1.58		47	0.23	16 16	1.62		17	0.23	16 6	1.62		46	0.23	65 / 70.7
26	17 3	1.58		51 1	.25	53	1.62		31	.23	43	1.62		52 0	.23	64 / 69.9
27	41	1.58		16	.25	17 30	1.62		45	.25	17 20	1.67		14	.25	63 / 69.1
28	18 19	1.62		31	.27	18 7	1.62		52 0	.27	56	1.62		29	.27	62 / 68.3
29	56	1.62		47	.27	44	1.62		16	.27	18 33	1.67		45	.28	61 / 67.5
30	19 33	1.62		52 3	0.28	19 21	1.67		32	0.28	19 9	1.67		53 2	0.28	60 / 66.6
31	20 10	1.67		20	.30	57	1.67		49	.30	45	1.67		19	.28	59 / 65.8
32	46	1.67		38	.30	20 33	1.67		53 7	.30	20 21	1.71		36	.30	58 / 64.9
33	21 22	1.67		56	.32	21 9	1.67		25	.32	56	1.71		54	.32	57 / 64.1
34	58	1.67		53 15	.33	45	1.71		44	.33	21 31	1.71		54 13	.33	56 / 63.2
35	22 34	1.67		35	0.35	22 20	1.71		54 4	0.33	22 6	1.71		33	0.33	55 / 62.3
36	23 10	1.71		56	.35	55	1.71		24	.35	41	1.76		53	.35	54 / 61.4
37	45	1.71		54 17	.37	23 30	1.71		45	.37	23 15	1.76		55 14	.35	53 / 60.6
38	24 20	1.76		39	.37	24 5	1.76		55 7	.37	49	1.76		35	.37	52 / 59.7
39	54	1.76		55 1	.38	39	1.76		29	.38	24 23	1.76		57	.38	51 / 58.8
40	25 28	1.76		24	0.40	25 13	1.82		52	0.40	57	1.82		56 20	0.40	50 / 57.9
41	26 2	1.76		48	.42	46	1.82		56 16	.42	25 30	1.82		44	.40	49 / 56.9
42	36	1.82		56 13	.42	26 19	1.82		41	.42	26 3	1.88		57 8	.42	48 / 56.0
43	27 9	1.82		38	.43	52	1.88		57 6	.43	35	1.88		33	.43	47 / 55.1
44	42	1.88		57 4	.45	27 24	1.88		32	.43	27 7	1.94		59	.43	46 / 54.1
45	28 14			31		56			58		38			58 25		45 / 53.2
t	a	60′/Δ		b	Δ/60′	a	60′/Δ		b	Δ/60′	a	60′/Δ		b	Δ/60′	a
	$d = 48° 0'$					$d = 48° 30'$					$d = 49° 0'$					

b / B	a = 48° 0′					a = 48° 30′					a = 49° 0′					c / C	a / β
	h \ d	60′/Δ	Z \ t	Δ/60′		h \ d	60′/Δ	Z \ t	Δ/60′		h \ d	60′/Δ	Z \ t	Δ/60′			
°	° ′		° ′			° ′		° ′			° ′		° ′			°	°
45	28 14	1.88	57 31	0.47		27 56	1.88	57 58	0.47		27 38	1.94	58 25	0.45		45	53.2
46	46	1.88	59	.47		28 28	1.94	58 26	.47		28 9	1.94	52	.47		44	52.2
47	29 18	1.94	58 27	.48		59	1.94	54	.48		40	1.94	59 20	.48		43	51.2
48	49	1.94	56	.50		29 30	2.00	59 23	.48		29 11	2.00	49	.48		42	50.2
49	30 20	2.00	59 26	.50		30 0	2.00	52	.50		41	2.07	60 18	.50		41	49.3
50	50	2.00	56	0.53		30	2.00	60 22	0.52		30 10	2.07	48	0.52		40	48.2
51	31 20	2.07	60 28	.53		31 0	2.07	53	.53		39	2.07	61 19	.53		39	47.2
52	49	2.07	61 0	.55		29	2.14	61 25	.55		31 8	2.14	51	.53		38	46.2
53	32 18	2.14	33	.57		57	2.14	58	.57		36	2.22	62 23	.55		37	45.2
54	46	2.14	62 7	.57		32 25	2.22	62 32	.57		32 3	2.22	56	.57		36	44.1
55	33 14	2.22	41	0.60		52	2.22	63 6	0.58		30	2.22	63 30	0.58		35	43.1
56	41	2.22	63 17	.60		33 19	2.31	41	.58		57	2.31	64 5	.58		34	42.0
57	34 8	2.31	53	.62		45	2.31	64 16	.62		33 23	2.40	40	.60		33	40.9
58	34	2.31	64 30	.62		34 11	2.40	53	.62		48	2.40	65 16	.62		32	39.8
59	35 0	2.40	65 7	.65		36	2.40	65 30	.63		34 13	2.50	53	.63		31	38.7
60	25	2.50	46	.65		35 1	2.50	66 8	0.65		37	2.50	66 31	0.63		30	37.6
61	49	2.50	66 25	.67		25	2.61	47	.67		35 1	2.61	67 9	.65		29	36.5
62	36 13	2.61	67 5	.68		48	2.61	67 27	.67		24	2.73	48	.67		28	35.4
63	36	2.73	46	.70		36 11	2.73	68 7	.68		46	2.73	68 28	.67		27	34.2
64	58	2.73	68 28	.70		33	2.86	48	.70		36 8	2.86	69 8	.70		26	33.1
65	37 20	2.86	69 10	0.72		54	2.86	69 30	0.72		29	3.00	50	0.70		25	31.9
66	41	3.00	53	.73		37 15	3.00	70 13	.72		49	3.00	70 32	.70		24	30.7
67	38 1	3.00	70 37	.75		35	3.16	56	.73		37 9	3.16	71 14	.73		23	29.5
68	21	3.16	71 22	.75		54	3.16	71 40	.75		28	3.33	58	.73		22	28.3
69	40	3.33	72 7	.77		38 13	3.33	72 25	.75		46	3.53	72 42	.75		21	27.1
70	58	3.53	53	0.78		31	3.53	73 10	0.77		38 3	3.53	73 27	0.75		20	25.9
71	39 15	3.75	73 40	.78		48	3.75	56	.78		20	3.75	74 12	.77		19	24.7
72	31	3.75	74 27	.80		39 4	4.00	74 43	.78		36	4.00	58	.77		18	23.5
73	47	4.00	75 15	.82		19	4.00	75 30	.80		51	4.00	75 44	.78		17	22.2
74	40 2	4.29	76 4	.82		34	4.29	76 18	.80		39 6	4.62	76 31	.80		16	21.0
75	16	4.62	53	0.83		48	4.62	77 6	0.82		19	4.62	77 19	0.80		15	19.7
76	29	5.00	77 43	.83		40 1	5.00	55	.83		32	5.00	78 7	.82		14	18.4
77	41	5.00	78 33	.85		13	5.45	78 45	.83		44	5.45	56	.82		13	17.1
78	53	6.00	79 24	.85		24	6.00	79 35	.83		55	6.00	79 45	.83		12	15.8
79	41 3	6.00	80 15	.87		34	6.00	80 25	.85		40 5	6.00	80 35	.83		11	14.6
80	13	6.67	81 7	0.87		44	6.67	81 16	0.85		15	7.50	81 25	0.83		10	13.2
81	22	7.50	59	.88		53	7.50	82 7	.87		23	7.50	82 15	.85		9	11.9
82	30	8.57	82 52	.88		41 1	8.57	59	.87		31	8.57	83 6	.85		8	10.6
83	37	10.0	83 45	.88		8	10.0	83 51	.87		38	10.0	57	.85		7	9.3
84	43	12.0	84 38	.88		14	12.0	84 43	.87		44	12.0	84 48	.87		6	8.0
85	48	15.0	85 31	0.88		19	15.0	85 35	0.88		49	15.0	85 40	0.87		5	6.7
86	52	15.0	86 24	.90		23	20.0	86 28	.88		53	20.0	86 32	.87		4	5.3
87	56	30.0	87 18	.90		26	30.0	87 21	.88		56	30.0	87 24	.87		3	4.0
88	58	30.0	88 12	.90		28	30.0	88 14	.88		58	30.0	88 16	.87		2	2.7
89	42 0	—	89 6	.90		30	—	89 7	.88		41 0	—	89 8	.87		1	1.3
90	0		90 0			30		90 0			0		90 0			0	0.0
t	a	60′/Δ	b	Δ/60′		a	60′/Δ	b	Δ/60′		a	60′/Δ	b	Δ/60′			a
	d = 48° 0′					d = 48° 30′					d = 49° 0′						

b / B	a = 49° 30′						a = 50° 0′						a = 50° 30′						c / C	a / β
	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′		
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
0	0 0		1.54	49 30		0.00	0 0		1.54	50 0		0.00	0 0		1.58	50 30		0.00	90	90.0
1		39	1.54		30	.02		39	1.58		0	.02		38	1.58		30	.02	89	89.2
2	1 18		1.54		31	.02	1 17		1.54		1	.02	1 16		1.58		31	.02	88	88.5
3		57	1.54		32	.03		56	1.58		2	.03		54	1.54		32	.03	87	87.7
4	2 36		1.54		34	.03	2 34		1.54		4	.03	2 33		1.58		34	.03	86	86.9
5	3 15		1.54		36	0.05	3 13		1.58		6	0.05	3 11		1.58		36	0.05	85	86.2
6		54	1.58		39	.07		51	1.54		9	.07		49	1.58		39	.07	84	85 4
7	4 32		1.54		43	.07	4 30		1.58		13	.07	4 27		1.58		43	.07	83	84.6
8	5 11		1.54		47	.07	5 8		1.58		17	.07	5 5		1.58		47	.07	82	83.9
9		50	1.54		51	.08		46	1.54		21	.08		43	1.62		51	.08	81	83.1
10	6 29		1.58		56	0.08	6 25		1.58		26	0.08	6 20		1.58		56	0.08	80	82.3
11	7 7		1.54	50 1		.10	7 3		1.58		31	.10		58	1.58	51 1		.10	79	81.5
12		46	1.58		7	.12		41	1.58		37	.12	7 36		1.58		7	.12	78	80.8
13	8 24		1.58		14	.12	8 19		1.58		44	.12	8 14		1.62		14	.12	77	80.0
14	9 2		1.58		21	.13		57	1.58		51	.13		51	1.58		21	.12	76	79.2
15		40	1.58		29	0.13	9 35		1.62		59	0.13	9 29		1.62		28	0.13	75	78.4
16	10 18		1.58		37	.15	10 12		1.58	51 7		.13	10 6		1.62		36	.15	74	77.6
17		56	1.58		46	.15		50	1.58		15	.15		43	1.62		45	.15	73	76.8
18	11 34		1.58		55	.17	11 28		1.62		24	.17	11 20		1.62		54	.17	72	76 0
19	12 12		1.58	51 5		.17	12 5		1.62		34	.18		57	1.62	52 4		.17	71	75.2
20		50	1.58		15	0.18		42	1.62		45	0.18	12 34		1.62		14	0.18	70	74.4
21	13 28		1.62		26	.20	13 19		1.62		56	.18	13 11		1.67		25	.20	69	73.6
22	14 5		1.62		38	.20		56	1.62	52 7		.20		47	1.67		37	.20	68	72.8
23		42	1.62		50	.20	14 33		1.67		19	.22	14 23		1.67		49	.20	67	72.0
24	15 19		1.62	52 2		.22	15 9		1.62		32	.22		59	1.67	53 1		.22	66	71.2
25		56	1.62		15	0.23		46	1.67		45	0.23	15 35		1.67		14	0.23	65	70.3
26	16 33		1.67		29	.25	16 22		1.67		59	.23	16 11		1.67		28	.23	64	69.5
27	17 9		1.67		44	.25		58	1.67	53 13		.25		47	1.67		42	.25	63	68.7
28		45	1.67		59	.27	17 34		1.67		28	.27	17 23		1.71		57	.27	62	67.8
29	18 21		1.67	53 15		.27	18 10		1.71		44	.27		58	1.71	54 13		.27	61	67 0
30		57	1.67		31	0.28		45	1.71	54 0		0.28	18 33		1.71		29	0.28	60	66.1
31	19 33		1.71		48	.28	19 20		1.71		17	.28	19 8		1.76		46	.28	59	65.3
32	20 8		1.71	54 5		.30		55	1.71		34	.30		42	1.76	55 3		.30	58	64.4
33		43	1.71		23	.32	20 30		1.76		52	.32	20 16		1.76		21	.30	57	63.6
34	21 18		1.76		42	.32	21 4		1.76	55 11		.32		50	1.76		39	.32	56	62.7
35		52	1.76	55 1		0.33		38	1.76		30	0.33	21 24		1.82		58	0.33	55	61.8
36	22 26		1.76		21	.35	22 12		1.76		50	.33		57	1.82	56 18		.35	54	60.9
37	23 0		1.76		42	.35		46	1.82	56 10		.37	22 30		1.82		39	.35	53	60.0
38		34	1.82	56 3		.37	23 19		1.82		32	.37	23 3		1.82	57 0		.37	52	59.1
39	24 7		1.82		25	.38		52	1.88		54	.37		36	1.88		22	.37	51	58.2
40		40	1.82		48	0.40	24 24		1.88	57 16		0.38	24 8		1.88		44	0.38	50	57.3
41	25 13		1.88	57 12		.40		56	1.88		39	.40		40	1.94	58 7		.40	49	56.3
42		45	1.88		36	.42	25 28		1.88	58 3		.42	25 11		1.94		31	.40	48	55.4
43	26 17		1.88	58 1		.42	26 0		1.94		28	.42		42	1.94		55	.42	47	54.5
44		49	1.94		26	.43		31	1.94		53	.43	26 13		1.94	59 20		.43	46	53.5
45	27 20				52		27 2			59 19				44			46		45	52.5
t	a	60′/Δ	b	Δ/60′			a	60′/Δ	b	Δ/60′			a	60′/Δ	b	Δ/60′				a
	d = 49° 30′						d = 50° 0′						d = 50° 30′							

b / B	a = 49° 30′						a = 50° 0′						a = 50° 30′						c / C	a / β
	d / h		60′/Δ	t / Z		Δ/60′	d / h		60′/Δ	t / Z		Δ/60′	d / h		60′/Δ	t / Z		Δ/60′		
°	°	′		°	′		°	′		°	′		°	′		°	′			°
45	27	20	1.94	58	52	0.45	27	2	2.00	59	19	0.45	26	44	2.00	59	46	0.43	45	52.5
46		51	2.00	59	19	.47		32	2.00		46	.45	27	14	2.07	60	12	.45	44	51.6
47	28	21	2.00		47	.47	28	2	2.00	60	13	.47		43	2.07		39	.47	43	50.6
48		51	2.00	60	15	.48		32	2.07		41	.48	28	12	2.07	61	7	.48	42	49.6
49	29	21	2.07		44	.50	29	1	2.07	61	10	.50		41	2.07		36	.48	41	48.6
50		50	2.07	61	14	0.52		30	2.14		40	0.50	29	10	2.14	62	5	0.50	40	47.6
51	30	19	2.14		45	.52		58	2.14	62	10	.52		38	2.22		35	.52	39	46.6
52		47	2.14	62	16	.53	30	26	2.22		41	.53	30	5	2.22	63	6	.52	38	45.6
53	31	15	2.22		48	.55		53	2.22	63	13	.53		32	2.31		37	.53	37	44.5
54		42	2 22	63	21	.55	31	20	2.31		45	.55		58	2.31	64	9	.55	36	43.5
55	32	9	2.31		54	0.57		46	2.31	64	18	0.57	31	24	2.40		42	0.55	35	42.4
56		35	2.40	64	28	.58	32	12	2.40		52	.57		49	2.40	65	15	.57	34	41.4
57	33	0	2.40	65	3	.60		37	2.40	65	26	.60	32	14	2.40		49	.58	33	40.3
58		25	2.40		39	.60	33	2	2.50	66	2	.60		39	2.50	66	24	.60	32	39.2
59		50	2.50	66	15	.62		26	2.50		38	.60	33	3	2.61	67	0	.60	31	38.1
60	34	14	2.61		52	0.63		50	2.61	67	14	0.63		26	2.73		36	0.62	30	37.0
61		37	2.61	67	30	.65	34	13	2.73		52	.63		48	2.73	68	13	.63	29	35.9
62	35	0	2.73	68	9	.65		35	2.86	68	30	.65	34	10	2.86		51	.63	28	34.8
63		22	2.86		48	.67		56	2.86	69	9	.65		31	2.86	69	29	.65	27	33.6
64		43	2.86	69	28	.68	35	17	2.86		48	.67		52	3.00	70	8	.67	26	32.5
65	36	4	3.00	70	9	0 70		38	3.00	70	28	0.68	35	12	3.16		48	0.67	25	31.3
66		24	3.16		51	.70		58	3.16	71	9	.70		31	3.16	71	28	.68	24	30.2
67		43	3.16	71	33	.72	36	17	3.33		51	.70		50	3.33	72	9	.68	23	29.0
68	37	2	3.33	72	16	.72		35	3.33	72	33	.72	36	8	3.33		50	.70	22	27.8
69		20	3.53		59	.73		53	3.53	73	16	.72		26	3.75	73	32	.72	21	26.6
70		37	3.75	73	43	0.75	37	10	3.75		59	0.73		42	3.75	74	15	0.73	20	25.4
71		53	3.75	74	28	.75		26	4.00	74	43	.75		58	4.00		59	.73	19	24.2
72	38	9	4.00	75	13	.77		41	4.00	75	28	.75	37	13	4.00	75	43	.73	18	23.0
73		24	4.29		59	.77		56	4.29	76	13	.77		28	4.29	76	27	.75	17	21.8
74		38	4.62	76	45	.78	38	10	4.62		59	.77		42	4.62	77	12	.75	16	20.5
75		51	4.62	77	32	0.80		23	5.00	77	45	0.78		55	5.00		57	0.77	15	19.3
76	39	4	5.00	78	20	.80		35	5.00	78	32	.78	38	7	5.45	78	43	.78	14	18.0
77		16	5.45	79	8	.80		47	6.00	79	19	.78		18	6.00	79	30	.78	13	16.8
78		27	6.00		56	.82		57	6.00	80	6	.80		28	6.00	80	17	.78	12	15.5
79		37	6.67	80	45	.82	39	7	6.67		54	.80		38	6.67	81	4	.78	11	14.2
80		46	7.50	81	34	0.82		16	7.50	81	42	0.82		47	7.50		51	0.80	10	13.0
81		54	7.50	82	23	.83		24	7.50	82	31	.82		55	7.50	82	39	.80	9	11.7
82	40	2	10.0	83	13	.83		32	10.0	83	20	.83	39	3	10.0	83	27	.82	8	10.4
83		8	10.0	84	3	.85		38	10.0	84	10	.82		9	10.0	84	16	.82	7	9.1
84		14	12.0		54	.85		44	12.0		59	.83		15	15.0	85	5	.82	6	7.8
85		19	15.0	85	45	0.85		49	15.0	85	49	0.83		19	15.0		54	0.82	5	6.5
86		23	20.0	86	36	.85		53	20.0	86	39	.83		23	20.0	86	43	.82	4	5.2
87		26	30.0	87	27	.85		56	30.0	87	29	.83		26	30.0	87	32	.82	3	3.9
88		28	30.0	88	18	.85		58	30.0	88	19	.85		28	30.0	88	21	.82	2	2.6
89		30	—	89	9	.85	40	0	—	89	10	.83		30	—	89	10	.83	1	1.3
90		30		90	0			0		90	0			30		90	0		0	0.0
t	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′								a
	d = 49° 30′				d = 50° 0′				d = 50° 30′											

b / B	a = 51° 0′						a = 51° 30′						a = 52° 0′						c / C	a / β
	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′		
	°	′		°	′		°	′		°	′		°	′		°	′			
0	0	0	1.58	51	0	0.00	0	0	1.62	51	30	0.00	0	0	1.62	52	0	0.00	90	90.0
1		38	1.58		0	.02		37	1.58		30	.02		37	1.62		0	.02	89	89.2
2	1	16	1.62		1	.02	1	15	1.62		31	.02	1	14	1.62		1	.02	88	88.4
3		53	1.58		2	.03		52	1.62		32	.03		51	1.62		2	.03	87	87.7
4	2	31	1.58		4	.03	2	29	1.58		34	.03	2	28	1.62		4	.03	86	86.9
5	3	9	1.58		6	0.05	3	7	1.62		36	0.05	3	5	1.67		6	0.05	85	86.1
6		47	1.62		9	.07		44	1.62		39	.05		41	1.62		9	.05	84	85.3
7	4	24	1.58		13	.07	4	21	1.62		42	.07	4	18	1.62		12	.07	83	84.5
8	5	2	1.62		17	.07		58	1.62		46	.08		55	1.62		16	.08	82	83.7
9		39	1.62		21	.08	5	35	1.62		51	.08	5	32	1.67		21	.08	81	82.9
10	6	16	1.58		26	0.08	6	12	1.62		56	0.08	6	8	1.62		26	0.08	80	82.1
11		54	1.62		31	.10		49	1.62	52	1	.10		45	1.67		31	.10	79	81.4
12	7	31	1.62		37	.12	7	26	1.62		7	.10	7	21	1.62		37	.10	78	80.6
13	8	8	1.62		44	.12	8	3	1.62		13	.12		58	1.67		43	.12	77	79.8
14		45	1.62		51	.12		40	1.67		20	.13	8	34	1.67		50	.13	76	79.0
15	9	22	1.62		58	0.13	9	16	1.62		28	0.13	9	10	1.67		58	0.13	75	78.2
16		59	1.62	52	6	.15		53	1.67		36	.15		46	1.67	53	6	.13	74	77.4
17	10	36	1.62		15	.15	10	29	1.67		45	.15	10	22	1.67		14	.15	73	76.5
18	11	13	1.67		24	.17	11	5	1.67		54	.15		58	1.67		23	.17	72	75.7
19		49	1.62		34	.17		41	1.67	53	3	.17	11	34	1.71		33	.17	71	74.9
20	12	26	1.67		44	0.18	12	17	1.67		13	0.18	12	9	1.67		43	0.18	70	74.1
21	13	2	1.67		55	.18		53	1.67		24	.18		45	1.71		54	.18	69	73.3
22		38	1.67	53	6	.20	13	29	1.67		35	.20	13	20	1.71	54	5	.20	68	72.5
23	14	14	1.67		18	.20	14	5	1.71		47	.22		55	1.71		17	.20	67	71.6
24		50	1.67		30	.22		40	1.71	54	0	.22	14	30	1.71		29	.22	66	70.8
25	15	26	1.71		43	0.23	15	15	1.71		13	0.22	15	5	1.71		42	0.22	65	70.0
26	16	1	1.71		57	.23		50	1.71		26	.23		40	1.76		55	.23	64	69.1
27		36	1.71	54	11	.25	16	25	1.71		40	.25	16	14	1.76	55	9	.25	63	68.3
28	17	11	1.71		26	.27	17	0	1.76		55	.25		48	1.76		24	.25	62	67.4
29		46	1.76		42	.27		34	1.76	55	10	.27	17	22	1.76		39	.27	61	66.5
30	18	20	1.71		58	0.27	18	8	1.76		26	0.28		56	1.82		55	0.27	60	65.7
31		55	1.76	55	14	.28		42	1.76		43	.28	18	29	1.82	56	11	.28	59	64.8
32	19	29	1.76		31	.30	19	16	1.82	56	0	.30	19	2	1.82		28	.30	58	63.9
33	20	3	1.76		49	.30		49	1.82		18	.30		35	1.82		46	.30	57	63.1
34		37	1.82	56	7	.32	20	22	1.82		36	.32	20	8	1.82	57	4	.32	56	62.2
35	21	10	1.82		26	0.33		55	1.82		55	0.32		41	1.88		23	0.32	55	61.3
36		43	1.82		46	.35	21	28	1.88	57	14	.33	21	13	1.88		42	.33	54	60.4
37	22	16	1.88	57	7	.35	22	0	1.88		34	.35		45	1.88	58	2	.35	53	59.5
38		48	1.88		28	.35		32	1.88		55	.37	22	17	1.94		23	.35	52	58.6
39	23	20	1.88		49	.37	23	4	1.94	58	17	.37		48	1.94		44	.37	51	57.6
40		52	1.94	58	11	0.38		35	1.94		39	0.38	23	19	1.94	59	6	0.38	50	56.7
41	24	23	1.94		34	.40	24	6	1.94	59	2	.38		50	2.00		29	.38	49	55.8
42		54	1.94		58	.40		37	2.00		25	.40	24	20	2.00		52	.38	48	54.8
43	25	25	2.00	59	22	.42	25	7	2.00		49	.40		50	2.07	60	15	.42	47	53.9
44		55	2.00		47	.42		37	2.00	60	13	.43	25	19	2.07		40	.42	46	52.9
45	26	25		60	12		26	7			39			48		61	5		45	52.0

t	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a
	d = 51° 0′				d = 51° 30′				d = 52° 0′				

b / B	a = 51° 0′ h	d	60′/Δ	Z	t	Δ/60′	a = 51° 30′ h	d	60′/Δ	Z	t	Δ/60′	a = 52° 0′ h	d	60′/Δ	Z	t	Δ/60′	c / C	a / β
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
45	26 25		2.00	60 12		0.43	26 7		2.07	60 39		0.43	25 48		2.07	61 5		0.43	45	52.0
46	55		2.07	38		.45	36		2.07	61 5		.43	26 17		2.07	31		.43	44	51.0
47	27 24		2.07	61 5		.47	27 5		2.14	31		.45	46		2.14	57		.45	43	50.0
48	53		2.14	33		.47	33		2.14	58		.47	27 14		2.22	62 24		.47	42	49.0
49	28 21		2.14	62 1		.48	28 1		2.14	62 26		.48	41		2.22	52		.47	41	48.0
50	49		2.14	30		0.50	29		2.22	55		0.48	28 8		2.22	63 20		0.48	40	47.0
51	29 17		2.22	63 0		.50	56		2.22	63 24		.50	35		2.31	49		.50	39	46.0
52	44		2.31	30		.52	29 23		2.31	54		.52	29 1		2.31	64 19		.50	38	45.0
53	30 10		2.31	64 1		.53	49		2.31	64 25		.52	27		2.40	49		.52	37	43.9
54	36		2.31	33		.53	30 15		2.40	56		.53	52		2.40	65 20		.53	36	42.9
55	31 2		2.40	65 5		0.55	40		2.50	65 28		0.55	30 17		2.50	52		0.53	35	41.8
56	27		2.50	38		.57	31 4		2.50	66 1		.57	41		2.50	66 24		.55	34	40.8
57	51		2.50	66 12		.58	28		2.50	35		.57	31 5		2.61	57		.57	33	39.7
58	32 15		2.50	47		.58	52		2.61	67 9		.57	28		2.61	67 31		.57	32	38.6
59	39		2.61	67 22		.60	32 15		2.73	43		.60	51		2.73	68 5		.58	31	37.5
60	33 2		2.73	58		0.60	37		2.73	68 19		0.60	32 13		2.73	40		0.58	30	36.4
61	24		2.86	68 34		.62	59		2.86	55		.60	35		2.86	69 15		.60	29	35.3
62	45		2.86	69 11		.63	33 20		2.86	69 31		.63	56		3.00	51		.62	28	34.2
63	34 6		2.86	49		.63	41		3.00	70 9		.63	33 16		3.00	70 28		.63	27	33.1
64	27		3.00	70 27		.65	34 1		3.00	47		.63	36		3.16	71 6		.63	26	31.9
65	47		3.16	71 6		0.67	21		3.16	71 25		0.65	55		3.33	44		0.63	25	30.8
66	35 6		3.33	46		.67	40		3.33	72 4		.67	34 13		3.33	72 22		.65	24	29.6
67	24		3.33	72 26		.68	58		3.53	44		.67	31		3.53	73 1		.67	23	28.5
68	42		3.53	73 7		.70	35 15		3.53	73 24		.68	48		3.53	41		.67	22	27.3
69	59		3.75	49		.70	32		3.75	74 5		.70	35 5		3.75	74 21		.68	21	26.1
70	36 15		3.75	74 31		0.72	48		4.00	47		0.70	21		4.00	75 2		0.70	20	24.9
71	31		4.00	75 14		.72	36 3		4.00	75 29		.70	36		4.29	44		.70	19	23.7
72	46		4.29	57		.73	18		4.29	76 11		.72	50		4.29	76 26		.70	18	22.5
73	37 0		4.62	76 41		.73	32		4.62	54		.73	36 4		4.62	77 8		.72	17	21.3
74	13		4.62	77 25		.75	45		4.62	77 38		.73	17		5.00	51		.72	16	20.1
75	26		5.00	78 10		0.75	58		5.00	78 22		0.73	29		5.00	78 34		0.73	15	18.9
76	38		5.45	55		.77	37 10		5.45	79 6		.75	41		5.45	79 18		.73	14	17.7
77	49		6.00	79 41		.77	21		6.00	51		.75	52		6.00	80 2		.73	13	16.5
78	59		6.00	80 27		.77	31		6.67	80 36		.77	37 2		6.67	46		.75	12	15.2
79	38 9		6.67	81 13		.78	40		6.67	81 22		.77	11		7.50	81 31		.75	11	13.9
80	18		7.50	82 0		0.78	49		7.50	82 8		0.77	19		7.50	82 16		0.77	10	12.7
81	26		8.57	47		.78	57		8.57	54		.78	27		8.57	83 2		.77	9	11.4
82	33		10.0	83 34		.80	38 4		10.0	83 41		.78	34		10.0	48		.77	8	10.2
83	39		10.0	84 22		.80	10		12.0	84 28		.78	40		12.0	84 34		.77	7	8.9
84	45		15.0	85 10		.80	15		15.0	85 15		.78	45		12.0	85 20		.77	6	7.6
85	49		15.0	58		0.80	19		15.0	86 2		0.78	50		20.0	86 6		0.78	5	6.4
86	53		20.0	86 46		.80	23		20.0	49		.80	53		20.0	53		.77	4	5.1
87	56		30.0	87 34		.82	26		30.0	87 37		.78	56		30.0	87 39		.78	3	3.8
88	58		30.0	88 23		.80	28		30.0	88 24		.80	58		30.0	88 26		.78	2	2.6
89	39 0		—	89 11		.82	30		—	89 12		.80	38 0		—	89 13		.78	1	1.3
90	0			90 0			30			90 0			0			90 0			0	0.0
t	a	60′/Δ		b	Δ/60′		a	60′/Δ		b	Δ/60′		a	60′/Δ		b	Δ/60′			a
	d = 51° 0′						d = 51° 30′						d = 52° 0′							

b / B	a = 52° 30′ h	d	60′/Δ	t Z	Δ/60′	a = 53° 0′ h	d	60′/Δ	t Z	Δ/60′	a = 53° 30′ h	d	60′/Δ	t Z	Δ/60′	c / C	a / β
°	° ′			° ′		° ′			° ′		° ′			° ′		°	°
0	0 0		1.62	52 30	0.00	0 0		1.67	53 0	0.00	0 0		1.67	53 30	0.00	90	90.0
1		37	1.67		30 .02		36	1.67		0 .02		36	1.71		30 .02	89	89.2
2	1 13		1.62		31 .02	1 12		1.67		1 .02	1 11		1.67		31 .02	88	88.4
3		50	1.67		32 .03		48	1.67		2 .03		47	1.67		32 .03	87	87.6
4	2 26		1.62		34 .03	2 24		1.67		4 .03	2 23		1.71		34 .03	86	86.8
5	3 3		1.67		36 0.05	3 0		1.67		6 0.05		58	1.67		36 0.05	85	86.0
6		39	1.67		39 .05		36	1.67		9 .05	3 34		1.71		39 .05	84	85.2
7	4 15		1.62		42 .07	4 12		1.67		12 .07	4 9		1.67		42 .07	83	84.4
8		52	1.67		46 .07		48	1.67		16 .07		45	1.71		46 .07	82	83.6
9	5 28		1.67		50 .08	5 24		1.67		20 .08	5 20		1.67		50 .08	81	82.8
10	6 4		1.67		55 0.10	6 0		1.67		25 0.08		56	1.71		55 0.08	80	82.0
11		40	1.67	53 1	.10		36	1.71		30 .10	6 31		1.71	54 0	.10	79	81.2
12	7 16		1.67		7 .10	7 11		1.67		36 .12	7 6		1.71		6 .10	78	80.4
13		52	1.67		13 .12		47	1.71		43 .12		41	1.71		12 .12	77	79.6
14	8 28		1.67		20 .12	8 22		1.67		50 .12	8 16		1.71		19 .13	76	78.7
15	9 4		1.67		27 0.13		58	1.71		57 0.13		51	1.71		27 0.13	75	77.9
16		40	1.71		35 .15	9 33		1.71	54 5	.13	9 26		1.71		35 .13	74	77.1
17	10 15		1.67		44 .15	10 8		1.71		13 .15	10 1		1.71		43 .15	73	76.3
18		51	1.71		53 .15		43	1.71		22 .17		36	1.76		52 .15	72	75.5
19	11 26		1.71	54 2	.17	11 18		1.71		32 .17	11 10		1.76	55 1	.17	71	74.6
20	12 1		1.71		12 0.18		53	1.76		42 0.17		44	1.76		11 0.18	70	73.8
21		36	1.71		23 .18	12 27		1.71		52 .18	12 18		1.76		22 .18	69	73.0
22	13 11		1.71		34 .20	13 2		1.76	55 3	.20		52	1.76		33 .18	68	72.1
23		46	1.76		46 .20		36	1.76		15 .20	13 26		1.76		44 .20	67	71.3
24	14 20		1.76		58 .22	14 10		1.76		27 .22	14 0		1.76		56 .22	66	70.4
25		54	1.76	55 11	0.22		44	1.76		40 0.22		34	1.82	56 9	0.22	65	69.6
26	15 28		1.76		24 .23	15 18		1.82		53 .23	15 7		1.82		22 .23	64	68.7
27	16 2		1.76		38 .25		51	1.76	56 7	.25		40	1.82		36 .23	63	67.9
28		36	1.76		53 .25	16 25		1.82		22 .25	16 13		1.82		50 .25	62	67.0
29	17 10		1.82	56 8	.27		58	1.82		37 .25		46	1.88	57 5	.27	61	66.1
30		43	1.82		24 0.27	17 31		1.88		52 0.27	17 18		1.88		21 0.27	60	65.2
31	18 16		1.82		40 .28	18 3		1.82	57 8	.28		50	1.88		37 .28	59	64.4
32		49	1.82		57 .28		36	1.88		25 .28	18 22		1.88		54 .28	58	63.5
33	19 22		1.88	57 14	.30	19 8		1.88		42 .30		54	1.88	58 11	.30	57	62.6
34		54	1.88		32 .32		40	1.88	58 0	.32	19 26		1.94		29 .30	56	61.7
35	20 26		1.88		51 0.32	20 12		1.94		19 0.32		57	1.94		47 0.32	55	60.8
36		58	1.88	58 10	.33		43	1.94		38 .33	20 28		1 94	59 6	.32	54	59.9
37	21 30		1.94		30 .33	21 14		1.94		58 .33		59	2.00		25 .33	53	59.0
38	22 1		1.94		50 .35		45	2.00	59 18	.35	21 29		2.00		45 .35	52	58.0
39		32	2.00	59 11	.37	22 15		2.00		39 .35		59	2.00	60 6	.35	51	57.1
40	23 2		2.00		33 0.37		45	2.00	60 0	0.37	22 29		2.07		27 0.37	50	56.2
41		32	2.00		55 .38	23 15		2.00		22 .38		58	2.07		49 .38	49	55.2
42	24 2		2.00	60 18	.40		45	2.07		45 .38	23 27		2.07	61 12	.38	48	54.3
43		32	2.07		42 .40	24 14		2.07	61 8	.40		56	2.14		35 .40	47	53.3
44	25 1		2.07	61 6	.42		43	2.14		32 .42	24 24		2.14		59 .40	46	52.4
45		30			31	25 11				57		52		62 23		45	51.4

t	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′		a
	d = 52° 30′				d = 53° 0′				d = 53° 30′					

0.767 0.754 0.740

b / B	a = 52° 30′					a = 53° 0′					a = 53° 30′					c / C	a / β
	h \ d	60′/Δ		Z \ t	Δ/60′	h \ d	60′/Δ		Z \ t	Δ/60′	h \ d	60′/Δ		Z \ t	Δ/60′		
°	° ′			° ′		° ′			° ′		° ′			° ′		°	°
45	25 30	2.14		61 31	0.43	25 11	2.14		61 57	0.42	24 52	2.14		62 23	0.42	45	51.4
46	58	2.14		57	.43	39	2.14		62 22	.43	25 20	2.22		48	.42	44	50.4
47	26 26	2.14		62 23	.45	26 7	2.22		48	.45	47	2.22		63 13	.43	43	49.4
48	54	2.22		50	.45	34	2.22		63 15	.45	26 14	2.31		39	.45	42	48.4
49	27 21	2.22		63 17	.47	27 1	2.31		42	.45	40	2.31		64 6	.47	41	47.4
50	48	2.31		45	0.48	27	2.31		64 9	0.48	27 6	2.31		34	0.47	40	46.4
51	28 14	2.31		64 14	.48	53	2.31		38	.48	32	2.40		65 2	.48	39	45.4
52	40	2.40		43	.50	28 19	2.40		65 7	.48	57	2.40		31	.48	38	44.4
53	29 5	2.40		65 13	.52	44	2.50		36	.50	28 22	2.50		66 0	.50	37	43.3
54	30	2.40		44	.52	29 8	2.50		66 6	.52	46	2.50		30	.50	36	42.3
55	55	2.50		66 15	0.53	32	2.50		37	0.53	29 10	2.61		67 0	0.52	35	41.2
56	30 19	2.61		47	.53	56	2.61		67 9	.53	33	2.61		31	.53	34	40.2
57	42	2.61		67 19	.55	30 19	2.73		41	.55	56	2.73		68 3	.53	33	39.1
58	31 5	2.73		52	.57	41	2.73		68 14	.55	30 18	2.86		35	.55	32	38.0
59	27	2.73		68 26	.58	31 3	2.73		47	.57	39	2.86		69 8	.57	31	37.0
60	49	2.86		69 1	0.58	25	2.86		69 21	0.58	31 0	2.86		42	0.57	30	35.9
61	32 10	2.86		36	.58	46	3.00		56	.58	21	3.00		70 16	.58	29	34.8
62	31	3.00		70 11	.60	32 6	3.00		70 31	.60	41	3.16		51	.58	28	33.7
63	51	3.16		47	.62	26	3.16		71 7	.60	32 0	3.16		71 26	.60	27	32.5
64	33 10	3.16		71 24	.63	45	3.33		43	.62	19	3.33		72 2	.60	26	31.4
65	29	3.33		72 2	0.63	33 3	3.33		72 20	0.63	37	3.33		38	0.62	25	30.3
66	47	3.33		40	.65	21	3.53		58	.63	55	3.53		73 15	.62	24	29.1
67	34 5	3.53		73 19	.65	38	3.53		73 36	.63	33 12	3.75		52	.63	23	28.0
68	22	3.75		58	.65	55	3.75		74 14	.65	28	3.75		74 30	.65	22	26.8
69	38	3.75		74 37	.68	34 11	4.00		53	.67	44	4.00		75 9	.65	21	25.7
70	54	4.00		75 18	0.68	26	4.00		75 33	0.67	59	4.29		48	0.65	20	24.5
71	35 9	4.29		59	.68	41	4.29		76 13	.68	34 13	4.29		76 27	.67	19	23.3
72	23	4.62		76 40	.68	55	4.62		54	.68	27	4.62		77 7	.67	18	22.1
73	36	4.62		77 21	.70	35 8	4.62		77 35	.68	40	5.00		47	.68	17	20.9
74	49	5.00		78 3	.72	21	5.00		78 16	.70	52	5.00		78 28	.68	16	19.7
75	36 1	5.45		46	0.72	33	5.45		58	0.70	35 4	5.45		79 9	0.70	15	18.5
76	12	5.45		79 29	.72	44	6.00		79 40	.72	15	6.00		51	.70	14	17.3
77	23	6.00		80 12	.73	54	6.00		80 23	.72	25	6.00		80 33	.70	13	16.1
78	33	6.67		56	.73	36 4	6.67		81 6	.72	35	6.67		81 15	.72	12	14.9
79	42	7.50		81 40	.75	13	7.50		49	.73	44	7.50		58	.72	11	13.7
80	50	8.57		82 25	0.73	21	8.57		82 33	0.73	52	8.57		82 41	0.72	10	12.5
81	57	8.57		83 9	.75	28	8.57		83 17	.73	59	10.0		83 24	.72	9	11.2
82	37 4	10.0		54	.75	35	10.0		84 1	.73	36 5	10.0		84 7	.73	8	10.0
83	10	12.0		84 39	.77	41	12.0		45	.75	11	12.0		51	.73	7	8.7
84	15	12.0		85 25	.75	46	15.0		85 30	.75	16	15.0		85 35	.73	6	7.5
85	20	15.0		86 10	0.77	50	15.0		86 15	0.75	20	15.0		86 19	0.73	5	6.3
86	24	20.0		56	.77	54	20.0		87 0	.75	24	20.0		87 3	.73	4	5.0
87	27	30.0		87 42	.77	57	30.0		45	.75	27	30.0		47	.73	3	3.8
88	29	60.0		88 28	.77	59	60.0		88 30	.75	29	60.0		88 31	.75	2	2.5
89	30	—		89 14	.77	37 0	—		89 15	.75	30	—		89 16	.73	1	1.3
90	30			90 0		0			90 0		30			90 0		0	0.0
t	a	60′/Δ	b		Δ/60′	a	60′/Δ	b		Δ/60′	a	60′/Δ	b		Δ/60′		a
	d = 52° 30′					d = 53° 0′					d = 53° 30′						

	0.727			0.713			0.700				
b / B	a = 54° 0′			a = 54° 30′			a = 55° 0′			c / C	a / β
	d / h	60′/Δ	t / Z	d / h	60′/Δ	t / Z	d / h	60′/Δ	t / Z		
°	° ′		° ′	° ′		° ′	° ′		° ′	°	°
0	0 0	1.71	54 0	0 0	1.71	54 30	0 0	1.76	55 0	90	90.0
1	35	1.67	0	35	1.71	30	34	1.71	0	89	89.2
2	1 11	1.71	1	1 10	1.76	31	1 9	1.76	1	88	88.4
3	46	1.71	2	44	1.71	32	43	1.71	2	87	87.6
4	2 21	1.71	4	2 19	1.71	34	2 18	1.76	4	86	86.7
5	56	1.71	6	54	1.71	36	52	1.76	6	85	85.9
6	3 31	1.71	9	3 29	1.76	39	3 26	1.76	9	84	85.1
7	4 6	1.71	12	4 3	1.71	42	4 0	1.71	12	83	84.3
8	41	1.71	16	38	1.71	46	35	1.76	16	82	83.5
9	5 16	1.71	20	5 13	1.76	50	5 9	1.76	20	81	82.7
10	51	1.71	25	47	1.71	55	43	1.76	25	80	81.8
11	6 26	1.71	30	6 22	1.76	55 0	6 17	1.76	30	79	81.0
12	7 1	1.71	36	56	1.76	6	51	1.76	36	78	80.2
13	36	1.71	42	7 30	1.76	12	7 25	1.76	42	77	79.4
14	8 11	1.76	49	8 4	1.76	19	59	1.82	49	76	78.5
15	45	1.76	56	38	1.76	26	8 32	1.76	56	75	77.7
16	9 19	1.71	55 4	9 12	1.76	34	9 6	1.82	56 3	74	76.9
17	54	1.76	12	46	1.76	42	39	1.76	11	73	76.0
18	10 28	1.76	21	10 20	1.76	51	10 13	1.82	20	72	75.2
19	11 2	1.76	31	54	1.82	56 0	46	1.82	29	71	74.3
20	36	1.76	41	11 27	1.76	10	11 19	1.82	39	70	73.5
21	12 10	1.82	51	12 1	1.82	20	52	1.82	49	69	72.6
22	43	1.76	56 2	34	1.82	31	12 25	1.88	57 0	68	71.8
23	13 17	1.82	14	13 7	1.82	43	57	1.82	12	67	70.9
24	50	1.82	26	40	1.82	55	13 30	1.88	24	66	70.1
25	14 23	1.82	38	14 13	1.88	57 7	14 2	1.88	36	65	69.2
26	56	1.82	51	45	1.88	20	34	1.88	49	64	68.3
27	15 29	1.88	57 5	15 17	1.88	34	15 6	1.94	58 2	63	67.5
28	16 1	1.88	19	49	1.88	48	37	1.88	16	62	66.6
29	33	1.88	34	16 21	1.88	58 3	16 9	1.94	31	61	65.7
30	17 5	1.88	49	53	1.94	18	40	1.94	46	60	64.8
31	37	1.88	58 5	17 24	1.94	34	17 11	1.94	59 2	59	63.9
32	18 9	1.94	22	55	1.94	50	42	2.00	18	58	63.0
33	40	1.94	39	18 26	1.94	59 7	18 12	2.00	35	57	62.1
34	19 11	1.94	56	57	2.00	24	42	2.00	52	56	61.2
35	42	1.94	59 14	19 27	2.00	42	19 12	2.00	60 10	55	60.3
36	20 13	2.00	33	57	2.00	60 1	42	2.00	28	54	59.4
37	43	2.00	52	20 27	2.00	20	20 12	2.07	47	53	58.5
38	21 13	2.00	60 12	57	2.07	40	41	2.07	61 7	52	57.5
39	43	2.07	33	21 26	2.07	61 0	21 10	2.14	27	51	56.6
40	22 12	2.07	54	55	2.07	21	38	2.14	48	50	55.7
41	41	2.07	61 16	22 24	2.14	42	22 6	2.14	62 9	49	54.7
42	23 10	2.14	38	52	2.14	62 4	34	2.14	31	48	53.8
43	38	2.14	62 1	23 20	2.14	27	23 2	2.22	53	47	52.8
44	24 6	2.14	25	48	2.22	50	29	2.22	63 16	46	51.8
45	34		49	24 15		63 14	56		40	45	50.9
t	a	60′/Δ	b	a	60′/Δ	b	a	60′/Δ	b		a
	d = 54° 0′			d = 54° 30′			d = 55° 0′				

b / B	a = 54° 0′					a = 54° 30′					a = 55° 0′					c / C	a / β
	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′		
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
45	24 34		2.22	62 49		0.40	24 15		2.22	63 14		0.40	23 56		2.31	63 40		0.40	45	50.9
46	25 1		2.22	63 13		.42	42		2.31	38		.42	24 22		2.31	64 4		.42	44	49.9
47	28		2.31	38		.43	25 8		2.31	64 3		.43	48		2.31	29		.42	43	48.9
48	54		2.31	64 4		.45	34		2.31	29		.43	25 14		2.40	54		.43	42	47.9
49	26 20		2.31	31		.45	26 0		2.40	55		.45	39		2.40	65 20		.43	41	46.9
50	46		2.40	58		0.47	25		2.40	65 22		0.45	26 4		2.50	46		0.45	40	45.9
51	27 11		2.40	65 26		.47	50		2.50	49		.47	28		2.50	66 13		.47	39	44.8
52	36		2.50	54		.48	27 14		2.50	66 17		.48	52		2.50	41		.47	38	43.8
53	28 0		2.50	66 23		.48	38		2.61	46		.48	27 16		2.61	67 9		.48	37	42.8
54	24		2.61	52		.50	28 1		2.61	67 15		.50	39		2.61	38		.48	36	41.7
55	47		2.61	67 22		0.52	24		2.61	45		0.50	28 2		2.73	68 7		0.50	35	40.7
56	29 10		2.73	53		.53	47		2.73	68 15		.52	24		2.86	37		.52	34	39.6
57	32		2.73	68 25		.53	29 9		2.86	46		.53	45		2.86	69 8		.52	33	38.6
58	54		2.86	57		.53	30		2.86	69 18		.53	29 6		2.86	39		.52	32	37.5
59	30 15		2.86	69 29		.55	51		3.00	50		.53	27		3.00	70 10		.53	31	36.4
60	36		3.00	70 2		0.57	30 11		3.00	70 22		0.55	47		3.00	42		0.55	30	35.3
61	56		3.00	36		.57	31		3.00	55		.57	30 7		3.16	71 15		.55	29	34.3
62	31 16		3.16	71 10		.58	51		3.16	71 29		.57	26		3.33	48		.57	28	33.1
63	35		3.33	45		.58	31 10		3.33	72 3		.58	44		3.33	72 22		.57	27	32.0
64	53		3.33	72 20		.60	28		3.53	38		.58	31 2		3.53	56		.58	26	30.9
65	32 11		3.53	56		0.60	45		3.53	73 13		0.60	19		3.53	73 31		0.58	25	29.8
66	28		3.53	73 32		.62	32 2		3.53	49		.60	36		3.75	74 6		.60	24	28.7
67	45		3.75	74 9		.62	19		3.75	74 25		.62	52		3.75	42		.60	23	27.5
68	33 1		3.75	46		.63	35		4.00	75 2		.62	32 8		4.00	75 18		.62	22	26.4
69	17		4.00	75 24		.65	50		4.29	39		.63	23		4.29	55		.62	21	25.2
70	32		4.29	76 3		0.65	33 4		4.29	76 17		0.63	37		4.29	76 32		0.62	20	24.1
71	46		4.62	42		.65	18		4.62	55		.65	51		4.62	77 9		.63	19	22.9
72	59		4.62	77 21		.67	31		4.62	77 34		.65	33 4		5.00	47		.65	18	21.8
73	34 12		5.00	78 1		.67	44		5.00	78 13		.67	16		5.00	78 26		.65	17	20.6
74	24		5.45	41		.67	56		5.45	53		.67	28		5.45	79 5		.65	16	19.4
75	35		5.45	79 21		0.68	34 7		5.45	79 33		0.67	39		6.00	44		0.65	15	18.2
76	46		6.00	80 2		.68	18		6.00	80 13		.67	49		6.00	80 23		.67	14	17.0
77	56		6.00	43		.70	28		6.67	53		.68	59		8.57	81 3		.67	13	15.8
78	35 6		7.50	81 25		.70	37		7.50	81 34		.68	34 8		7.50	43		.67	12	14.6
79	14		7.50	82 7		.70	45		7.50	82 15		.68	16		7.50	82 23		.68	11	13.4
80	22		8.57	49		0.70	53		8.57	56		0.70	24		8.57	83 4		0.68	10	12.2
81	29		8.57	83 31		.70	35 0		10.0	83 38		.70	31		10.0	45		.68	9	11.0
82	36		12.0	84 13		.72	6		10.0	84 20		.70	37		12.0	84 26		.68	8	9.8
83	41		12.0	56		.72	12		12.0	85 2		.70	42		12.0	85 7		.70	7	8.6
84	46		15.0	85 39		.73	17		15.0	44		.70	47		15.0	49		.68	6	7.4
85	50		15.0	86 23		0.72	21		20.0	86 26		0.72	51		20.0	86 30		0.70	5	6.1
86	54		20.0	87 6		.72	24		20.0	87 9		.72	54		20.0	87 12		.70	4	4.9
87	57		30.0	49		.73	27		30.0	52		.70	57		30.0	54		.70	3	3.7
88	59		60.0	88 33		.72	29		60.0	88 34		.72	59		60.0	88 36		.70	2	2.5
89	36 0		—	89 16		.73	30		—	89 17		.72	35 0		—	89 18		.70	1	1.2
90	0			90 0			30			90 0			0			90 0			0	0.0
t	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′		a
	d = 54° 0′						d = 54° 30′						d = 55° 0′							

b / B	a = 55° 30′						a = 56° 0′						a = 56° 30′						c / C	a / β
	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′		
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
0	0 0		1.76	55 30		0.00	0 0		1.76	56 0		0.00	0 0		1.82	56 30		0.00	90	90.0
1		34	1.76		30	.02		34	1.82		0	.02		33	1.82		30	.02	89	89.2
2	1 8		1.76		31	.02	1 7		1.76		1	.02	1 6		1.82		31	.02	88	88.3
3		42	1.76		32	.03		41	1.82		2	.03		39	1.82		32	.03	87	87.5
4	2 16		1.76		34	.03	2 14		1.76		4	.03	2 12		1.82		34	.03	86	86.7
5		50	1.76		36	0.05		48	1.82		6	0.05		45	1.82		36	0.05	85	85.9
6	3 24		1.82		39	.05	3 21		1.82		9	.05	3 18		1.82		39	.05	84	85.0
7		57	1.76		42	.07		54	1.76		12	.07		51	1.82		42	.07	83	84.2
8	4 31		1.76		46	.07	4 28		1.82		16	.07	4 24		1.82		46	.07	82	83.4
9	5 5		1.76		50	.08	5 1		1.82		20	.07		57	1.82		50	.07	81	82.5
10		39	1.82		55	0.08		34	1.82		24	0.08	5 30		1.82		54	0.08	80	81.7
11	6 12		1.76	56 0		.08	6 7		1.82		29	.10	6 3		1.88		59	.10	79	80.8
12		46	1.82		5	.10		40	1.82		35	.10		35	1.82	57 5		.10	78	80.0
13	7 19		1.76		11	.12	7 13		1.82		41	.12	7 8		1.88		11	.12	77	79.2
14		53	1.82		18	.12		46	1.82		48	.12		40	1.82		18	.12	76	78.3
15	8 26		1.82		25	0.13	8 19		1.82		55	0.13	8 13		1.88		25	0.12	75	77.5
16		59	1.82		33	.13		52	1.82	57 3		.13		45	1.88		32	.13	74	76.6
17	9 32		1.82		41	.15	9 25		1.88		11	.13	9 17		1.88		40	.15	73	75.8
18	10 5		1.82		50	.15		57	1.88		19	.15		49	1.88		49	.15	72	74.9
19		38	1.88		59	.17	10 29		1.88		28	.17	10 21		1.88		58	.15	71	74.1
20	11 10		1.82	57 9		0.17	11 1		1.88		38	0.17		53	1.88	58 7		0.17	70	73.2
21		43	1.88		19	.18		33	1.88		48	.18	11 25		1.94		17	.18	69	72.3
22	12 15		1.88		30	.18	12 5		1.88		59	.18		56	1.94		28	.18	68	71.5
23		47	1.88		41	.20		37	1.88	58 10		.20	12 27		1.94		39	.18	67	70.6
24	13 19		1.88		53	.20	13 9		1.94		22	.20		58	1.94		50	.20	66	69.7
25		51	1.88	58 5		0.22		40	1.94		34	0.22	13 29		1.94	59 2		0.22	65	68.9
26	14 23		1.94		18	.22	14 11		1.94		47	.22	14 0		1.94		15	.22	64	68.0
27		54	1.94		31	.23		42	1.94	59 0		.23		31	2.00		28	.23	63	67.1
28	15 25		1.94		45	.23	15 13		1.94		14	.23	15 1		2.00		42	.23	62	66.2
29		56	1.94		59	.25		44	2.00		28	.25		31	2.00		56	.25	61	65.3
30	16 27		1.94	59 14		0.27	16 14		2.00		43	0.25	16 1		2.00	60 11		0.25	60	64.4
31		58	2.00		30	.27		44	2.00		58	.27		31	2.00		26	.27	59	63.5
32	17 28		2.00		46	.28	17 14		2.00	60 14		.27	17 1		2.07		42	.27	58	62.6
33		58	2.00	60 3		.28		44	2.07		30	.28		30	2.07		58	.28	57	61.7
34	18 28		2.00		20	.28	18 13		2.07		47	.30		59	2.07	61 15		.28	56	60.8
35		58	2.07		37	0.30		42	2.07	61 5		0.30	18 28		2.14		32	0.30	55	59.9
36	19 27		2.07		55	.32	19 11		2.07		23	.30		56	2.14		50	.30	54	58.9
37		56	2.07	61 14		.33		40	2.14		41	.32	19 24		2.14	62 8		.32	53	58.0
38	20 25		2.14		34	.33	20 8		2.14	62 0		.33		52	2.14		27	.33	52	57.1
39		53	2.14		54	.33		36	2.14		20	.33	20 20		2.22		47	.33	51	56.1
40	21 21		2.14	62 14		0.35	21 4		2.22		40	0.35		47	2.22	63 7		0.33	50	55.2
41		49	2.22		35	.37		31	2.22	63 1		.37	21 14		2.22		27	.35	49	54.2
42	22 16		2.22		57	.37		58	2.22		23	.37		41	2.31		48	.37	48	53.3
43		43	2.22	63 19		.38	22 25		2.31		45	.37	22 7		2.31	64 10		.37	47	52.3
44	23 10		2.22		42	.38		51	2.31	64 7		.38		33	2.40		32	.38	46	51.3
45		37		64 5			23 17				30			58			55		45	50.3

t	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′		a
	d = 55° 30′				d = 56° 0′				d = 56° 30′					

b / B	$a = 55° 30'$						$a = 56° 0'$						$a = 56° 30'$						c / C	a / β
	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′		
°	°	′		°	′		°	′		°	′		°	′		°	′		°	°
45	23	37	2.31	64	5	0.40	23	17	2.31	64	30	0.40	22	58	2.40	64	55	0.38	45	50.3
40	24	3	2.40		29	.40		43	2.40		54	.40	23	23	2.40	65	18	.40	44	49.4
47		28	2.40		53	.42	24	8	2.40	65	18	.42		48	2.40		42	.42	43	48.4
48		53	2.40	65	18	.43		33	2.40		43	.42	24	13	2.50	66	7	.42	42	47.4
49	25	18	2.40		44	.43		58	2.50	66	8	.43		37	2.50		32	.42	41	46.4
50		43	2.50	66	10	0.45	25	22	2.50		34	0.43	25	1	2.61		57	0.43	40	45.3
51	26	7	2.50		37	.45		46	2.61	67	0	.45		24	2.61	67	23	.45	39	44.3
52		31	2.61	67	4	.47	26	9	2.61		27	.45		47	2.73		50	.45	38	43.3
53		54	2.73		32	.47		32	2.73		54	.47	26	9	2.73	68	17	.47	37	42.3
54	27	16	2.73	68	0	.48		54	2.73	68	22	.48		31	2.73		45	.47	36	41.2
55		38	2.73		29	0.50	27	16	2.86		51	0.48		53	2.86	69	13	0.47	35	40.2
56	28	0	2.73		59	.50		37	2.86	69	20	.50	27	14	3.00		41	.48	34	39.1
57		22	2.86	69	29	.50		58	3.00		50	.50		34	3.00	70	10	.50	33	38.1
58		43	3.00		59	.52	28	18	3.00	70	20	.52		54	3.00		40	.50	32	37.0
59	29	3	3.00	70	30	.53		38	3.00		51	.52	28	14	3.16	71	10	.52	31	35.9
60		23	3.16	71	2	0.53		58	3.16	71	22	0.53		33	3.16		41	0.52	30	34.9
61		42	3.33		34	.55	29	17	3.33		54	.53		52	3.33	72	12	.53	29	33.8
62	30	0	3.33	72	7	.55		35	3.33	72	26	.55	29	10	3.53		44	.53	28	32.7
63		18	3.33		40	.57		53	3.53		59	.55		27	3.53	73	16	.55	27	31.6
64		36	3.53	73	14	.57	30	10	3.53	73	32	.55		44	3.53		49	.55	26	30.5
65		53	3.53		48	0.58		27	3.75	74	5	0.57	30	1	3.75	74	22	0.57	25	29.4
66	31	10	3.75	74	23	.58		43	3.75		39	.58		17	4.00		56	.57	24	28.2
67		26	4.00		58	.60		59	4.00	75	14	.58		32	4.00	75	30	.57	23	27.1
68		41	4.29	75	34	.60	31	14	4.29		49	.60		47	4.29	76	4	.58	22	26.0
69		55	4.29	76	10	.60		28	4.29	76	25	.60	31	1	4.62		39	.60	21	24.8
70	32	9	4.29		46	0.62		42	4.62	77	1	0.60		14	4.62	77	15	0.58	20	23.7
71		23	4.62	77	23	.62		55	4.62		37	.62		27	4.62		50	.60	19	22.6
72		36	5.00	78	0	.63	32	8	5.00	78	14	.62		40	5.00	78	26	.62	18	21.4
73		48	5.45		38	.63		20	5.45		51	.62		52	5.45	79	3	.62	17	20.2
74		59	5.45	79	16	.65		31	5.45	79	28	.63	32	3	6.00		40	.62	16	19.1
75	33	10	6.00		55	0.65		42	6.00	80	6	0.63		13	6.00	80	17	0.62	15	17.9
76		20	6.00	80	34	.65		52	6.67		44	.63		23	6.67		54	.63	14	16.7
77		30	6.67	81	13	.65	33	1	6.67	81	22	.65		32	7.50	81	32	.63	13	15.6
78		39	7.50		52	.67		10	7.50	82	1	.65		40	7.50	82	10	.63	12	14.4
79		47	8.57	82	32	.67		18	8.57		40	.65		48	8.57		48	.63	11	13.2
80		54	8.57	83	12	0.67		25	8.57	83	19	0.67		55	8.57	83	26	0.65	10	12.0
81	34	1	10.0		52	.67		32	10.0		59	.65	33	2	10.0	84	5	.65	9	10.8
82		7	12.0	84	32	.68		38	12.0	84	38	.67		8	12.0		44	.65	8	9.6
83		12	12.0	85	13	.67		43	15.0	85	18	.67		13	15.0	85	23	.67	7	8.4
84		17	15.0		53	.68		47	15.0		58	.67		17	15.0	86	3	.65	6	7.2
85		21	20.0	86	34	0.68		51	20.0	86	38	0.67		21	20.0		42	0.65	5	6.0
86		24	20.0	87	15	.68		54	20.0	87	18	.68		24	20.0	87	21	.67	4	4.8
87		27	30.0		56	.70		57	30.0		59	.67		27	30.0	88	1	.67	3	3.6
88		29	60.0	88	38	.68		59	60.0	88	39	.67		29	60.0		41	.65	2	2.4
89		30	—	89	19	.68	34	0	—	89	19	.68		30	—	89	20	.67	1	1.2
90		30		90	0			0		90	0			30		90	0		0	0.0
t	a	60′/Δ	b	Δ/60′			a	60′/Δ	b	Δ/60′			a	60′/Δ	b	Δ/60′				a
	$d = 55° 30'$						$d = 56° 0'$						$d = 56° 30'$							

b / B	$a = 57° 0'$						$a = 57° 30'$						$a = 58° 0'$						c / C	a / β
	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′		
°	°	′		°	′		°	′		°	′		°	′		°	′		°	°
0	0	0	1.82	57	0	0.00	0	0	1.88	57	30	0.00	0	0	1.88	58	0	0.00	90	90.0
1		33	1.88		0	.02		32	1.88		30	.02		32	1.88		0	.02	89	89.2
2	1	5	1.82		1	.02	1	4	1.82		31	.02	1	4	1.94		1	.02	88	88.3
3		38	1.82		2	.03		37	1.88		32	.03		35	1.88		2	.03	87	87.5
4	2	11	1.88		4	.03	2	9	1.88		34	.03	2	7	1.88		4	.03	86	86.6
5		43	1.82		6	0.05		41	1.88		36	0.05		39	1.88		6	0.03	85	85.8
6	3	16	1.88		9	.05	3	13	1.88		39	.05	3	11	1.94		8	.05	84	84.9
7		48	1.82		12	.05		45	1.88		42	.05		42	1.88		11	.07	83	84.1
8	4	21	1.88		15	.07	4	17	1.88		45	.07	4	14	1.94		15	.07	82	83.2
9		53	1.82		19	.08		49	1.88		49	.08		45	1.88		19	.08	81	82.4
10	5	26	1.88		24	0.08	5	21	1.88		54	0.08	5	17	1.94		24	0.08	80	81.5
11		58	1.88		29	.10		53	1.88		59	.08		48	1.88		29	.08	79	80.7
12	6	30	1.88		35	.10	6	25	1.88	58	4	.10	6	20	1.94		34	.10	78	79.8
13	7	2	1.88		41	.10		57	1.94		10	.12		51	1.94		40	.10	77	79.0
14		34	1.88		47	.12	7	28	1.88		17	.12	7	22	1.94		46	.12	76	78.1
15	8	6	1.88		54	0.13	8	0	1.94		24	0.12		53	1.94		53	0.12	75	77.3
16		38	1.88	58	2	.13		31	1.94		31	.13	8	24	1.94	59	0	.13	74	76.4
17	9	10	1.88		10	.13	9	2	1.94		39	.13		55	1.94		8	.15	73	75.5
18		42	1.94		18	.15		33	1.94		47	.15	9	26	2.00		17	.15	72	74.7
19	10	13	1.94		27	.15	10	4	1.94		56	.17		56	1.94		26	.15	71	73.8
20		44	1.94		36	0.17		35	1.94	59	6	0.17	10	27	2.00		35	0.17	70	72.9
21	11	15	1.94		46	.18	11	6	1.94		16	.17		57	2.00		45	.17	69	72.1
22		46	1.94		57	.18		37	2.00		26	.18	11	27	2.00		55	.18	68	71.2
23	12	17	1.94	59	8	.18	12	7	2.00		37	.18		57	2.00	60	6	.18	67	70.3
24		48	1.94		19	.20		37	2.00		48	.20	12	27	2.00		17	.20	66	69.4
25	13	19	2.00		31	0.22	13	7	2.00	60	0	0.20		57	2.07		29	0.20	65	68.5
26		49	2.00		44	.22		37	2.00		12	.22	13	26	2.07		41	.22	64	67.6
27	14	19	2.00		57	.22	14	7	2.00		25	.22		55	2.07		54	.22	63	66.7
28		49	2.00	60	10	.23		37	2.07		38	.23	14	24	2.07	61	7	.23	62	65.8
29	15	19	2.07		24	.25	15	6	2.07		52	.25		53	2.07		21	.23	61	64.9
30		48	2.07		39	0.25		35	2.07	61	7	0.25	15	22	2.14		35	0.25	60	64.0
31	16	17	2.07		54	.27	16	4	2.07		22	.25		50	2.14		50	.25	59	63.1
32		46	2.07	61	10	.27		33	2.14		37	.27	16	18	2.14	62	5	.27	58	62.2
33	17	15	2.07		26	.27	17	1	2.14		53	.28		46	2.14		21	.27	57	61.3
34		44	2.14		42	.28		29	2.14	62	10	.28	17	14	2.14		37	.28	56	60.4
35	18	12	2.14		59	0.30		57	2.14		27	0.28		42	2.22		54	0.28	55	59.4
36		40	2.14	62	17	.30	18	25	2.22		44	.30	18	9	2.22	63	11	.30	54	58.5
37	19	8	2.14		35	.32		52	2.22	63	2	.32		36	2.22		29	.30	53	57.6
38		36	2.22		54	.32	19	19	2.22		21	.32	19	3	2.31		47	.32	52	56.6
39	20	3	2.22	63	13	.33		46	2.31		40	.32		29	2.31	64	6	.32	51	55.7
40		30	2.31		33	0.33	20	12	2.31		59	0.33		55	2.31		25	0.33	50	54.7
41		56	2.31		53	.35		38	2.31	64	19	.35	20	21	2.40		45	.33	49	53.8
42	21	22	2.31	64	14	.37	21	4	2.31		40	.35		46	2.40	65	5	.35	48	52.8
43		48	2.31		36	.37		30	2.40	65	1	.37	21	11	2.40		26	.37	47	51.8
44	22	14	2.40		58	.37		55	2.40		23	.37		36	2.50		48	.37	46	50.8
45		39		65	20		22	20			45		22	0		66	10		45	49.9

t	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′		a
	$d = 57° 0'$				$d = 57° 30'$				$d = 58° 0'$					

b / B	a = 57° 0′						a = 57° 30′						a = 58° 0′						c / C	a / β
	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′		
°	°	′		°	′		°	′		°	′		°	′		°	′		°	°
45	22	39	2.40	65	20	0.38	22	20	2.50	65	45	0.38	22	0	2.50	66	10	0.37	45	49.9
46	23	4	2.50		43	.40		44	2.50	66	8	.38		24	2.50		32	.38	44	48.9
47		28	2.50	66	7	.40	23	8	2.50		31	.40		48	2.61		55	.38	43	47.9
48		52	2.50		31	.40		32	2.61		55	.40	23	11	2.61	67	18	.40	42	46.9
49	24	16	2.61		55	.42		55	2.61	67	19	.42		34	2.61		42	.42	41	45.9
50		39	2.61	67	20	0.43	24	18	2.61		44	0.42		57	2.73	68	7	0.42	40	44.9
51	25	2	2.61		46	.43		41	2.73	68	9	.43	24	19	2.73		32	.42	39	43.8
52		25	2.73	68	12	.45	25	3	2.73		35	.43		41	2.86		57	.43	38	42.8
53		47	2.73		39	.45		25	2.86	69	1	.45	25	2	2.86	69	23	.45	37	41.8
54	26	9	2.86	69	6	.47		46	2.86		28	.47		23	2.86		50	.45	36	40.7
55		30	2.86		34	0.47	26	7	3.00		56	0.47		44	3.00	70	17	0.45	35	39.7
56		51	3.00	70	2	.48		27	3.00	70	24	.47	26	4	3.16		44	.47	34	38.7
57	27	11	3.00		31	.50		47	3.16		52	.48		23	3.16	71	12	.48	33	37.6
58		31	3.16	71	1	.50	27	6	3.16	71	21	.48		42	3.16		41	.48	32	36.5
59		50	3.16		31	.50		25	3.16		50	.50	27	1	3.33	72	10	.48	31	35.5
60	28	9	3.33	72	1	0.52		44	3.33	72	20	0.50		19	3.33		39	0.50	30	34.4
61		27	3.33		32	.52	28	2	3.53		50	.52		37	3.53	73	9	.50	29	33.3
62		45	3.53	73	3	.53		19	3.53	73	21	.52		54	3.53		39	.52	28	32.2
63	29	2	3.53		35	.53		36	3.53		52	.53	28	11	3.75	74	10	.52	27	31.1
64		19	3.75	74	7	.53		53	3.75	74	24	.53		27	4.00		41	.52	26	30.0
65		35	4.00		39	0.55	29	9	4.00		56	0.53		42	4.00	75	12	0.53	25	28.9
66		50	4.00	75	12	.57		24	4.00	75	28	.55		57	4.00		44	.55	24	27.8
67	30	5	4.00		46	.57		39	4.29	76	1	.57	29	12	4.29	76	17	.55	23	26.7
68		20	4.29	76	20	.57		53	4.62		35	.55		26	4.62		50	.55	22	25.6
69		34	4.62		54	.58	30	6	4.62	77	8	.57		39	4.62	77	23	.55	21	24.5
70		47	4.62	77	29	0.58		19	4.62		42	0.58		52	5.00		56	0.57	20	23.3
71	31	0	5.00	78	4	.58		32	5.00	78	17	.58	30	4	5.00	78	30	.57	19	22.2
72		12	5.45		39	.60		44	5.45		52	.58		16	5.45	79	4	.58	18	21.1
73		23	5.45	79	15	.60		55	5.45	79	27	.58		27	6.00		39	.58	17	19.9
74		34	6.00		51	.60	31	6	6.00	80	2	.60		37	6.00	80	14	.58	16	18.8
75		44	6.00	80	27	0.62		16	6.67		38	0.60		47	6.67		49	0.58	15	17.6
76		54	6.67	81	4	.62		25	6.67	81	14	.62		56	6.67	81	24	.60	14	16.5
77	32	3	7.50		41	.63		34	7.50		51	.60	31	5	7.50	82	0	.60	13	15.3
78		11	7.50	82	19	.62		42	7.50	82	27	.62		13	7.50		36	.60	12	14.1
79		19	8.57		56	.63		50	8.57	83	4	.62		21	8.57	83	12	.60	11	13.0
80		26	10.0	83	34	0.63		57	10.0		41	0.62		28	10.0		48	0.62	10	11.8
81		32	10.0	84	12	.63	32	3	10.0	84	18	.63		34	12.0	84	25	.62	9	10.6
82		38	12.0		50	.63		9	12.0		56	.63		39	12.0	85	2	.62	8	9.5
83		43	12.0	85	28	.65		14	15.0	85	34	.62		44	15.0		39	.62	7	8.3
84		48	15.0	86	7	.65		18	15.0	86	11	.63		48	15.0	86	16	.62	6	7.1
85		52	20.0		46	0.63		22	20.0		49	0.63		52	20.0		53	0.62	5	5.9
86		55	30.0	87	24	.65		25	30.0	87	27	.63		55	30.0	87	30	.63	4	4.7
87		57	30.0	88	3	.65		27	30.0	88	5	.65		57	30.0	88	8	.62	3	3.6
88		59	60.0		42	.65		29	60.0		44	.63		59	60.0		45	.63	2	2.4
89	33	0	—	89	21	.65		30	—	89	22	.63	32	0	—	89	23	.62	1	1.2
90		0		90	0			30		90	0			0		90	0		0	0.0

t	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a
	d = 57° 0′				d = 57° 30′				d = 58° 0′				

b / B	a = 58° 30′						a = 59° 0′						a = 59° 30′						c / C	a / β
	h \ d	60′/Δ		Z \ t	Δ/60′		h \ d	60′/Δ		Z \ t	Δ/60′		h \ d	60′/Δ		Z \ t	Δ/60′			
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
0	0 0	1.94		58 30	0.00		0 0	1.94		59 0	0.00		0 0	2.00		59 30	0.00		90	90.0
1	31	1.88		30	.02		31	1.94		0	.02		30	1.94		30	.02		89	89.1
2	1 3	1.94		31	.02		1 2	1.94		1	.02		1 1	2.00		31	.02		88	88.3
3	34	1.94		32	.03		33	1.94		2	.03		31	1.94		32	.03		87	87.4
4	2 5	1.88		34	.03		2 4	2.00		4	.03		2 2	2.00		34	.03		86	86.6
5	37	1.94		36	0.03		34	1.94		6	0.03		32	2.00		36	0.03		85	85.7
6	3 8	1.94		38	.05		3 5	1.94		8	.05		3 2	1.94		38	.05		84	84.9
7	39	1.94		41	.07		36	1.94		11	.07		33	2.00		41	.07		83	84.0
8	4 10	1.94		45	.07		4 7	2.00		15	.07		4 3	2.00		45	.07		82	83.1
9	41	1.94		49	.07		37	1.94		19	.07		33	2.00		49	.07		81	82.3
10	5 12	1.94		53	0.08		5 8	2.00		23	0.08		5 3	2.00		53	0.08		80	81.4
11	43	1.94		58	.10		38	1.94		28	.08		33	2.00		58	.08		79	80.5
12	6 14	1.94		59 4	.10		6 9	2.00		33	.10		6 3	2.00		60 3	.10		78	79.7
13	45	1.94		10	.10		39	2.00		39	.10		33	2.00		9	.10		77	78.8
14	7 16	1.94		16	.12		7 9	2.00		45	.12		7 3	2.00		15	.12		76	77.9
15	47	2.00		23	0.12		39	2.00		52	0.12		33	2.00		22	0.12		75	77.1
16	8 17	2.00		30	.13		8 9	2.00		59	.13		8 3	2.07		29	.13		74	76.2
17	47	2.00		38	.13		39	2.00		60 7	.13		32	2.07		37	.13		73	75.3
18	9 17	2.00		46	.15		9 9	2.00		15	.15		9 1	2.00		45	.13		72	74.4
19	47	2.00		55	.15		39	2.00		24	.15		31	2.07		53	.15		71	73.6
20	10 17	2.00		60 4	0.17		10 9	2.07		33	0.17		10 0	2.07		61 2	0.17		70	72.7
21	47	2.00		14	.17		38	2.07		43	.17		29	2.07		12	.17		69	71.8
22	11 17	2.00		24	.17		11 7	2.07		53	.17		58	2.14		22	.17		68	70.9
23	47	2.07		34	.18		36	2.07		61 3	.18		11 26	2.07		32	.18		67	70.0
24	12 16	2.07		45	.20		12 5	2.07		14	.20		55	2.14		43	.18		66	69.1
25	45	2.07		57	0.20		34	2.07		26	0.20		12 23	2.14		54	0.20		65	68.2
26	13 14	2.07		61 9	.22		13 3	2.14		38	.20		51	2.14		62 6	.20		64	67.3
27	43	2.07		22	.22		31	2.14		50	.22		13 19	2.14		18	.22		63	66.4
28	14 12	2.07		35	.23		59	2.14		62 3	.23		47	2.14		31	.22		62	65.5
29	41	2.14		49	.23		14 27	2.14		17	.23		14 15	2.22		44	.23		61	64.6
30	15 9	2.14		62 3	0.23		55	2.14		31	0.23		42	2.22		58	0.25		60	63.7
31	37	2.14		17	.25		15 23	2.22		45	.25		15 9	2.22		63 13	.25		59	62.8
32	16 5	2.22		32	.27		50	2.22		63 0	.25		36	2.22		28	.25		58	61.8
33	32	2.22		48	.27		16 17	2.22		15	.27		16 3	2.31		43	.25		57	60.9
34	59	2.22		63 4	.28		44	2.22		31	.28		29	2.31		58	.27		56	60.0
35	17 26	2.22		21	0.28		17 11	2.31		48	0.28		55	2.31		64 14	0.28		55	59.0
36	53	2.22		38	.28		37	2.31		64 5	.28		17 21	2.31		31	.28		54	58.1
37	18 20	2.31		55	.30		18 3	2.31		22	.30		47	2.40		48	.30		53	57.1
38	46	2.31		64 13	.32		29	2.31		40	.30		18 12	2.40		65 6	.30		52	56.2
39	19 12	2.31		32	.32		55	2.40		58	.32		37	2.40		24	.32		51	55.2
40	38	2.40		51	0.33		19 20	2.40		65 17	0.32		19 2	2.40		43	0.32		50	54.3
41	20 3	2.40		65 11	.33		45	2.40		36	.33		27	2.50		66 2	.33		49	53.3
42	28	2.40		31	.35		20 10	2.50		56	.35		51	2.50		22	.33		48	52.3
43	53	2.50		52	.35		34	2.50		66 17	.35		20 15	2.50		42	.33		47	51.4
44	21 17	2.50		66 13	.35		58	2.50		38	.35		39	2.61		67 2	.35		46	50.4
45	41			34			21 22			59			21 2			23			45	49.4
t	a	60′/Δ		b	Δ/60′		a	60′/Δ		b	Δ/60′		a	60′/Δ		b	Δ/60′			a
	d = 58° 30′						d = 59° 0′						d = 59° 30′							

b / B	$a = 58° 30'$ h	d	60′/Δ	Z	t	Δ/60′	$a = 59° 0'$ h	d	60′/Δ	Z	t	Δ/60′	$a = 59° 30'$ h	d	60′/Δ	Z	t	Δ/60′	c / C	a / β
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
45	21 41		2.50	66 34		0.37	21 22		2.61	66 59		0.37	21 2		2.61	67 23		0.37	45	49.4
46	22 5		2.61		56	.38	45		2.61	67 21		.37	25		2.73		45	.37	44	48.4
47	28		2.61	67 19		.38	22 8		2.73		43	.38	47		2.73	68 7		.37	43	47.4
48	51		2.61		42	.40	30		2.73	68 6		.38	22 9		2.73		29	.38	42	46.4
49	23 14		2.73	68 6		.40	52		2.73		29	.40	31		2.73		52	.40	41	45.4
50	36		2.73		30	0.42	23 14		2.73		53	0.40	53		2.86	69 16		0.40	40	44.4
51	58		2.86		55	.42	36		2.86	69 17		.42	23 14		2.86		40	.40	39	43.4
52	24 19		2.86	69 20		.42	57		3.00		42	.42	35		3.00	70 4		.42	38	42.3
53	40		3.00		45	.43	24 17		3.00	70 7		.43	55		3.00		29	.42	37	41.3
54	25 0		3.00	70 11		.45	37		3.00		33	.43	24 15		3.16		54	.43	36	40.3
55	20		3.00		38	0.45	57		3.00		59	0.45	34		3.16	71 20		0.43	35	39.2
56	40		3.16	71 5		.47	25 17		3.16	71 26		.45	53		3.16		46	.45	34	38.2
57	59		3.16		33	.47	36		3.33		53	.45	25 12		3.33	72 13		.45	33	37.1
58	26 18		3.33	72 1		.47	54		3.33	72 20		.47	30		3.53		40	.45	32	36.1
59	36		3.33		29	.48	26 12		3.53		48	.48	47		3.53	73 7		.47	31	35.0
60	54		3.33		58	0.48	29		3.53	73 17		0.48	26 4		3.53		35	0.48	30	34.0
61	27 12		3.53	73 27		.50	46		3.53		46	.48	21		3.75	74 4		.48	29	32.9
62	29		3.75		57	.50	27 3		3.75	74 15		.50	37		3.75		33	.48	28	31.8
63	45		3.75	74 27		.52	19		3.75		45	.50	53		4.00	75 2		.48	27	30.7
64	28 1		4.00		58	.52	35		4.00	75 15		.50	27 8		4.00		31	.50	26	29.6
65	16		4.00	75 29		0.52	50		4.29		45	0.52	23		4.29	76 1		0.50	25	28.5
66	31		4.29	76 0		.53	28 4		4.29	76 16		.52	37		4.29		31	.52	24	27.4
67	45		4.29		32	.53	18		4.62		47	.53	51		4.62	77 2		.52	23	26.3
68	59		4.62	77 4		.55	31		4.62	77 19		.53	28 4		4.62		33	.53	22	25.2
69	29 12		5.00		37	.55	44		4.62		51	.53	17		5.00	78 5		.53	21	24.1
70	24		5.00	78 10		0.55	57		5.00	78 23		0.55	29		5.00		37	0.53	20	23.0
71	36		5.00		43	.57	29 9		5.45		56	.55	41		5.45	79 9		.53	19	21.9
72	48		5.45	79 17		.57	20		6.00	79 29		.55	52		6.00		41	.55	18	20.8
73	59		6.00		51	.57	30		6.00	80 2		.57	29 2		6.00	80 14		.55	17	19.6
74	30 9		6.00	80 25		.57	40		6.00		36	.57	12		6.67		47	.55	16	18.5
75	19		6.67		59	0.58	50		6.67	81 10		0.57	21		6.67	81 20		0.55	15	17.4
76	28		7.50	81 34		.58	59		7.50		44	.57	30		7.50		53	.57	14	16.2
77	36		7.50	82 9		.58	30 7		7.50	82 18		.58	38		7.50	82 27		.57	13	15.1
78	44		8.57		44	.60	15		8.57		53	.58	46		8.57	83 1		.57	12	13.9
79	51		8.57	83 20		.60	22		8.57	83 28		.58	53		10.0		35	.58	11	12.8
80	58		10.0		56	0.60	29		10.0	84 3		0.58	59		10.0	84 10		0.57	10	11.6
81	31 4		12.0	84 32		.60	35		12.0		38	.58	30 5		12.0		44	.58	9	10.5
82	9		12.0	85 8		.60	40		12.0	85 13		.60	10		12.0	85 19		.58	8	9.3
83	14		15.0		44	.60	45		15.0		49	.58	15		15.0		54	.58	7	8.2
84	18		15.0	86 20		.60	49		20.0	86 24		.60	19		20.0	86 29		.58	6	7.0
85	22		20.0		56	0.62	52		20.0	87 0		0.60	22		20.0	87 4		0.58	5	5.8
86	25		30.0	87 33		.62	55		30.0		36	.60	25		30.0		39	.58	4	4.7
87	27		30.0	88 10		.60	57		30.0	88 12		.60	27		30.0	88 14		.58	3	3.5
88	29		60.0		46	.62	59		60.0		48	.60	29		60.0		49	.60	2	2.3
89	30		—	89 23		.62	31 0		—	89 24		.60	30		—	89 25		.58	1	1.2
90	30			90 0			0			90 0			30			90 0			0	0.0
t	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′		a
	$d = 58° 30'$						$d = 59° 0'$						$d = 59° 30'$							

b / B	$a = 60° 0'$						$a = 60° 30'$						$a = 61° 0'$						c / C	a / β
	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′		
°	°	′		°	′		°	′		°	′		°	′		°	′		°	°
0	0	0	2.00	60	0	0.00	0	0	2.00	60	30	0.00	0	0	2.07	61	0	0.00	90	90.0
1		30	2.00		0	.02		30	2.07		30	.02		29	2.07		0	.02	89	89.1
2	1	0	2.00		1	.02		59	2.00		31	.02		58	2.07		1	.02	88	88.3
3		30	2.00		2	.03	1	29	2.07		32	.03	1	27	2.07		2	.03	87	87.4
4	2	0	2.00		4	.03		58	2.00		34	.03		56	2.07		4	.03	86	86.5
5		30	2.00		6	0.03	2	28	2.07		36	0.03	2	25	2.07		6	0.03	85	85.6
6	3	0	2.00		8	.05		57	2.07		38	.05		54	2.07		8	.05	84	84.8
7		30	2.07		11	.05	3	26	2.00		41	.05	3	23	2.07		11	.05	83	83.9
8		59	2.00		14	.07		56	2.07		44	.07		52	2.07		14	.07	82	83.0
9	4	29	2.00		18	.08	4	25	2.07		48	.07	4	21	2.07		18	.07	81	82.2
10		59	2.00		23	0.08		54	2.07		52	0.08		50	2.07		22	0.08	80	81.3
11	5	29	2.07		28	.08	5	23	2.07		57	.08	5	19	2.14		27	.08	79	80.4
12		58	2.00		33	.08		52	2.07	61	2	.10		47	2.07		32	.10	78	79.5
13	6	28	2.07		38	.10	6	21	2.07		8	.10	6	16	2.14		38	.10	77	78.6
14		57	2.07		44	.12		50	2.07		14	.12		44	2.07		44	.10	76	77.8
15	7	26	2.07		51	0.12	7	19	2.07		21	0.12	7	13	2.14		50	0.12	75	76.9
16		55	2.07		58	.13		48	2.07		28	.12		41	2.14		57	.12	74	76.0
17	8	24	2.07	61	6	.13	8	17	2.14		35	.13	8	9	2.14	62	4	.13	73	75.1
18		53	2.07		14	.13		45	2.07		43	.13		37	2.14		12	.13	72	74.2
19	9	22	2.07		22	.15	9	14	2.14		51	.15	9	5	2.14		20	.15	71	73.3
20		51	2.14		31	0.15		42	2.14	62	0	0.15		33	2.22		29	0.15	70	72.4
21	10	19	2.07		40	.17	10	10	2.14		9	.17	10	0	2.14		38	.17	69	71.5
22		48	2.14		50	.18		38	2.14		19	.17		28	2.22		48	.17	68	70.6
23	11	16	2.14	62	1	.18	11	6	2.22		29	.18		55	2.22		58	.18	67	69.7
24		44	2.14		12	.18		33	2.14		40	.18	11	22	2.22	63	9	.18	66	68.8
25	12	12	2.14		23	0.20	12	1	2.22		51	0.20		49	2.22		20	0.18	65	67.9
26		40	2.22		35	.20		28	2.22	63	3	.20	12	16	2.22		31	.20	64	67.0
27	13	7	2.22		47	.20		55	2.22		15	.20		43	2.31		43	.20	63	66.1
28		34	2.22		59	.22	13	22	2.22		27	.22	13	9	2.31		55	.22	62	65.2
29	14	1	2.22	63	12	.23		49	2.31		40	.23		36	2.31	64	8	.22	61	64.2
30		28	2.22		26	0.23	14	15	2.31		54	0.23	14	2	2.31		21	0.23	60	63.3
31		55	2.22		40	.25		41	2.31	64	8	.23		28	2.40		35	.23	59	62.4
32	15	22	2.31		55	.25	15	7	2.31		22	.25		53	2.31		49	.25	58	61.5
33		48	2.31	64	10	.25		33	2.31		37	.25	15	19	2.40	65	4	.25	57	60.5
34	16	14	2.31		25	.27		59	2.40		52	.27		44	2.40		19	.27	56	59.6
35		40	2.31		41	0.28	16	24	2.40	65	8	0.27	16	9	2.40		35	0.27	55	58.6
36	17	6	2.40		58	.28		49	2.40		24	.28		34	2.50		51	.27	54	57.7
37		31	2.40	65	15	.28	17	14	2.40		41	.28		58	2.50	66	7	.28	53	56.7
38		56	2.40		32	.30		39	2.50		58	.30	17	22	2.50		24	.30	52	55.8
39	18	21	2.50		50	.30	18	3	2.50	66	16	.30		46	2.50		42	.30	51	54.8
40		45	2.50	66	8	0.32		27	2.50		34	0.32	18	10	2.61	67	0	0.30	50	53.9
41	19	9	2.50		27	.33		51	2.61		53	.32		33	2.61		18	.32	49	52.9
42		33	2.61		47	.33	19	14	2.61	67	12	.32		56	2.61		37	.32	48	51.9
43		56	2.61	67	7	.33		37	2.61		31	.33	19	19	2.73		56	.33	47	50.9
44	20	19	2.61		27	.35	20	0	2.61		51	.35		41	2.73	68	16	.33	46	50.0
45		42			48			23		68	12		20	3			36		45	49.0
t	a	60′/Δ	b	Δ/60′			a	60′/Δ	b	Δ/60′			a	60′/Δ	b	Δ/60′				a
	$d = 60° 0'$						$d = 60° 30'$						$d = 61° 0'$							

b / B	a = 60° 0′						a = 60° 30′						a = 61° 0′						c / C	a / β
	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′		
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
45	20 42		2.61	67 48		0.35	20 23		2.73	68 12		0.35	20 3		2.73	68 36		0.33	45	49.0
46	21 5		2.73	68 9		.37	45		2.73	33		.35	25		2.86	56		.35	44	48.0
47	27		2.73	31		.37	21 7		2.86	54		.37	46		2.86	69 17		.37	43	47.0
48	49		2.86	53		.37	28		2.86	69 16		.37	21 7		2.86	39		.37	42	46.0
49	22 10		2.86	69 15		.38	49		2.86	38		.38	28		3.00	70 1		.37	41	45.0
50	31		2.86	38		0.40	22 10		3.00	70 1		0.38	48		3.00	23		0.38	40	44.0
51	52		3.00	70 2		.40	30		3.00	24		.40	22 8		3.00	46		.38	39	42.9
52	23 12		3.00	26		.40	50		3.00	48		.40	28		3.16	71 9		.40	38	41.9
53	32		3.00	50		.42	23 10		3.16	71 12		.40	47		3.16	33		.40	37	40.9
54	52		3.16	71 15		.43	29		3.33	36		.42	23 6		3.33	57		.42	36	39.9
55	24 11		3.33	41		0.43	47		3.33	72 1		0.43	24		3.33	72 22		0.42	35	38.8
56	29		3.33	72 7		.43	24 5		3.33	27		.43	42		3.33	47		.42	34	37.8
57	47		3.33	33		.43	23		3.33	53		.43	24 0		3.53	73 12		.43	33	36.7
58	25 5		3.33	59		.45	41		3.53	73 19		.43	17		3.75	38		.43	32	35.7
59	23		3.53	73 26		.47	58		3.53	45		.45	33		3.75	74 4		.43	31	34.6
60	40		3.75	54		0.47	25 15		3.75	74 12		0.47	49		3.75	30		0.45	30	33.6
61	56		3.75	74 22		.47	31		4.00	40		.47	25 5		3.75	57		.47	29	32.5
62	26 12		4.00	50		.48	46		4.00	75 8		.47	21		4.00	75 25		.47	28	31.4
63	27		4.00	75 19		.48	26 1		4.00	36		.47	36		4.29	53		.47	27	30.3
64	42		4.00	48		.48	16		4.29	76 4		.48	50		4.29	76 21		.47	26	29.3
65	57		4.29	76 17		0.50	30		4.29	33		0.48	26 4		4.62	49		0.48	25	28.2
66	27 11		4.62	47		.50	44		4.62	77 2		.50	17		4.62	77 18		.48	24	27.1
67	24		4.62	77 17		.52	57		4.62	32		.50	30		4.62	47		.48	23	26.0
68	37		4.62	48		.52	27 10		5.00	78 2		.50	43		5.00	78 16		.50	22	24.9
69	50		5.00	78 19		.52	22		5.00	32		.52	55		5.45	46		.50	21	23.8
70	28 2		5.45	50		0.52	34		5.45	79 3		0.52	27 6		5.45	79 16		0.50	20	22.7
71	13		5.45	79 21		.53	45		5.45	34		.52	17		6.00	46		.52	19	21.6
72	24		6.00	53		.53	56		6.00	80 5		.52	27		6.00	80 17		.52	18	20.5
73	34		6.00	80 25		.53	28 6		6.67	36		.53	37		6.67	48		.52	17	19.4
74	44		6.67	57		.55	15		6.67	81 8		.53	46		6.67	81 19		.52	16	18.2
75	53		7.50	81 30		0.55	24		7.50	40		0.53	55		7.50	50		0.53	15	17.1
76	29 1		7.50	82 3		.55	32		7.50	82 12		.55	28 3		7.50	82 22		.53	14	16.0
77	9		7.50	36		.55	40		8.57	45		.53	11		8.57	54		.53	13	14.9
78	17		8.57	83 9		.57	47		8.57	83 17		.55	18		8.57	83 26		.53	12	13.8
79	24		10.0	43		.55	54		10.0	50		.55	25		10.0	58		.53	11	12.6
80	30		10.0	84 16		0.57	29 0		10.0	84 23		0.55	31		10.0	84 30		0.55	10	11.5
81	36		12.0	50		.57	6		12.0	56		.57	37		12.0	85 3		.53	9	10.3
82	41		15.0	85 24		.57	11		15.0	85 30		.55	42		15.0	35		.55	8	9.2
83	45		15.0	58		.58	15		15.0	86 3		.57	46		15.0	86 8		.55	7	8.0
84	49		20.0	86 33		.57	19		20.0	37		.57	50		20.0	41		.55	6	6.9
85	52		20.0	87 7		0.58	22		20.0	87 11		0.55	53		30.0	87 14		0.55	5	5.7
86	55		30.0	42		.57	25		30.0	44		.57	55		30.0	47		.55	4	4.6
87	57		30.0	88 16		.58	27		30.0	88 18		.57	57		30.0	88 20		.55	3	3.4
88	59		60.0	51		.57	29		60.0	52		.57	59		60.0	53		.57	2	2.3
89	30 0		—	89 25		.58	30		—	89 26		.57	29 0		—	89 27		.55	1	1.1
90	0			90 0			30			90 0			0			90 0			0	0.0
t	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′		a
	d = 60° 0′						d = 60° 30′						d = 61° 0′							

b / B	a = 61° 30′						a = 62° 0′						a = 62° 30′						c / C	a / β
	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′		
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
0	0 0		2.07	61 30		0.00	0 0		2.14	62 0		0.00	0 0		2.14	62 30		0.00	90	90.0
1		29	2.14		30	.02		28	2.14		0	.02		28	2.22		30	.02	89	89.1
2		57	2.07		31	.02		56	2.07		1	.02		55	2.14		31	.02	88	88.2
3	1	26	2.14		32	.02	1	25	2.14		2	.02	1	23	2.14		32	.02	87	87.4
4		54	2.07		33	.03		53	2.14		3	.03		51	2.22		33	.03	86	86.5
5	2	23	2.07		35	0.05	2	21	2.14		5	0.05	2	18	2.14		35	0.05	85	85.6
6		52	2.14		38	.05		49	2.14		8	.05		46	2.14		38	.05	84	84.7
7	3	20	2.07		41	.05	3	17	2.14		11	.05	3	14	2.22		41	.05	83	83.8
8		49	2.14		44	.07		45	2.14		14	.07		41	2.14		44	.05	82	82.9
9	4	17	2.14		48	.07	4	13	2.14		18	.07	4	9	2.22		47	.07	81	82.0
10		45	2.14		52	0.08		41	2.22		22	0.07		36	2.22		51	0.08	80	81.2
11	5	13	2.14		57	.08	5	8	2.14		26	.08	5	2	2.14		56	.08	79	80.3
12		41	2.14	62	2	.08		36	2.14		31	.10		31	2.22	63	1	.08	78	79.4
13	6	9	2.14		7	.10	6	4	2.22		37	.10		58	2.22		6	.10	77	78.5
14		37	2.14		13	.10		31	2.14		43	.10	6	25	2.22		12	.10	76	77.6
15	7	5	2.14		19	0.12		59	2.22		49	0.12		52	2.22		18	0.12	75	76.7
16		33	2.14		26	.12	7	26	2.22		56	.12	7	19	2.22		25	.12	74	75.8
17	8	1	2.14		33	.13		53	2.22	63	3	.13		46	2.31		32	.13	73	74.9
18		29	2.22		41	.13	8	20	2.22		11	.13	8	12	2.22		40	.13	72	74.0
19		56	2.14		49	.15		47	2.22		19	.13		39	2.31		48	.13	71	73.1
20	9	24	2.22		58	0.15	9	14	2.22		27	0.15	9	5	2.31		56	0.15	70	72.2
21		51	2.22	63	7	.17		41	2.22		36	.15		31	2.31	64	5	.15	69	71.3
22	10	18	2.22		17	.17	10	8	2.31		45	.17		57	2.31		14	.17	68	70.4
23		45	2.22		27	.17		34	2.31		55	.17	10	23	2.31		24	.17	67	69.5
24	11	12	2.31		37	.18	11	0	2.31	64	5	.18		49	2.31		34	.18	66	68.5
25		38	2.31		48	0.18		26	2.31		16	0.18	11	15	2.31		45	0.18	65	67.6
26	12	4	2.31		59	.20		52	2.31		27	.20		41	2.40		56	.18	64	66.7
27		30	2.31	64	11	.20	12	18	2.31		39	.20	12	6	2.40	65	7	.20	63	65.8
28		56	2.31		23	.22		44	2.40		51	.22		31	2.40		19	.20	62	64.9
29	13	22	2.31		36	.22	13	9	2.40	65	4	.22		56	2.40		31	.22	61	63.9
30		48	2.31		49	0.23		34	2.40		17	0.22	13	21	2.40		44	0.22	60	63.0
31	14	14	2.40	65	3	.23		59	2.40		30	.23		46	2.50		57	.23	59	62.1
32		39	2.40		17	.23	14	24	2.40		44	.23	14	10	2.50	66	11	.23	58	61.1
33	15	4	2.40		31	.25		49	2.50		58	.25		34	2.50		25	.23	57	60.2
34		29	2.50		46	.25	15	13	2.50	66	13	.25		58	2.50		39	.25	56	59.2
35		53	2.50	66	1	0.27		37	2.50		28	0.27	15	22	2.61		54	0.27	55	58.3
36	16	17	2.50		17	.27	16	1	2.50		44	.27		45	2.61	67	10	.27	54	57.3
37		41	2.50		33	.28		25	2.61	67	0	.27	16	8	2.61		26	.27	53	56.4
38	17	5	2.50		50	.28		48	2.61		16	.28		31	2.61		42	.28	52	55.4
39		29	2.61	67	7	.30	17	11	2.61		33	.28		54	2.73		59	.28	51	54.4
40		52	2.61		25	0.30		34	2.73		50	0.30	17	16	2.73	68	16	0.28	50	53.5
41	18	15	2.73		43	.32		56	2.73	68	8	.30		38	2.73		33	.30	49	52.5
42		37	2.73	68	2	.32	18	18	2.73		26	.32	18	0	2.86		51	.30	48	51.5
43		59	2.73		21	.32		40	2.73		45	.32		21	2.86	69	9	.32	47	50.5
44	19	21	2.73		40	.33	19	2	2.86	69	4	.33		42	2.86		28	.32	46	49.5
45		43		69	0			23			24		19	3			47		45	48.6
t	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′		a
	d = 61° 30′						d = 62° 0′						d = 62° 30′							

0.543 0.532 0.521

b / B	a = 61° 30′						a = 62° 0′						a = 62° 30′						c / C	a / β
	h \ d	60′/Δ		Z \ t		Δ/60′	h \ d	60′/Δ		Z \ t		Δ/60′	h \ d	60′/Δ		Z \ t		Δ/60′		
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
45	19 43	2.86		69 0		0.33	19 23	2.86		69 24		0.33	19 3	2.86		69 47		0.33	45	48.6
46	20 4	2.86		20		.35	44	2.86		44		.33	24	3.00		70 7		.33	44	47.6
47	25	2.86		41		.35	20 5	3.00		70 4		.35	44	3.00		27		.35	43	46.6
48	46	3.00		70 2		.37	25	3.00		25		.35	20 4	3.00		48		.35	42	45.6
49	21 6	3.00		24		.37	45	3.00		46		.37	24	3.16		71 9		.35	41	44.6
50	26	3.00		46		0.37	21 5	3.16		71 8		0.37	43	3.16		30		0.37	40	43.5
51	46	3.16		71 8		.38	24	3.16		30		.37	21 2	3.33		52		.37	39	42.5
52	22 5	3.16		31		.38	43	3.33		52		.38	20	3.33		72 14		.37	38	41.5
53	24	3.16		54		.40	22 1	3.33		72 15		.40	38	3.33		36		.38	37	40.5
54	43	3.33		72 18		.40	19	3.33		39		.38	56	3.53		59		.38	36	39.5
55	23 1	3.53		42		0.42	37	3.53		73 2		0.40	22 13	3.53		73 22		0.40	35	38.4
56	18	3.53		73 7		.42	54	3.53		26		.42	30	3.53		46		.40	34	37.4
57	35	3.53		32		.42	23 11	3.53		51		.42	47	3.75		74 10		.42	33	36.3
58	52	3.75		57		.43	28	3.75		74 16		.42	23 3	3.75		35		.42	32	35.3
59	24 8	3.75		74 23		.43	44	4.00		41		.43	19	4.00		75 0		.42	31	34.2
60	24	3.75		49		0.43	59	4.00		75 7		0.43	34	4.00		25		0.42	30	33.2
61	40	4.00		75 15		.45	24 14	4.00		33		.43	49	4.00		50		.43	29	32.1
62	55	4.00		42		.45	29	4.00		59		.45	24 4	4.29		76 16		.43	28	31.0
63	25 10	4.29		76 9		.47	44	4.29		76 26		.45	18	4.62		42		.45	27	30.0
64	24	4.29		37		.47	58	4.62		53		.45	31	4.62		77 9		.45	26	28.9
65	38	4.62		77 5		0.47	25 11	4.62		77 20		0.47	44	4.62		36		0.45	25	27.8
66	51	5.00		33		.47	24	5.00		48		.47	57	5.00		78 3		.45	24	26.8
67	26 3	5.00		78 1		.48	36	5.00		78 16		.47	25 9	5.00		30		.47	23	25.7
68	15	5.00		30		.48	48	5.00		44		.48	21	5.45		58		.47	22	24.6
69	27	5.45		59		.50	26 0	5.45		79 13		.48	32	5.45		79 26		.47	21	23.5
70	38	5.45		79 29		0.50	11	6.00		42		0.48	43	6.00		54		0.48	20	22.4
71	49	6.00		59		.50	21	6.00		80 11		.48	53	6.00		80 23		.48	19	21.3
72	59	6.00		80 29		.50	31	6.00		40		.50	26 3	6.67		52		.48	18	20.2
73	27 9	6.67		59		.50	41	6.67		81 10		.50	12	6.67		81 21		.48	17	19.1
74	18	6.67		81 29		.52	50	7.50		40		.50	21	7.50		50		.50	16	18.0
75	27	7.50		82 0		0.52	58	7.50		82 10		0.50	29	7.50		82 20		0.48	15	16.9
76	35	8.57		31		.52	27 6	8.57		40		.52	37	8.57		49		.50	14	15.8
77	42	8.57		83 2		.52	13	8.57		83 11		.50	44	8.57		83 19		.50	13	14.7
78	49	8.57		33		.53	20	10.0		41		.52	51	10.0		49		.52	12	13.5
79	56	10.0		84 5		.53	26	10.0		84 12		.52	57	10.0		84 20		.50	11	12.4
80	28 2	12.0		37		0.53	32	12.0		43		0.53	27 3	12.0		50		0.52	10	11.3
81	7	12.0		85 9		.53	37	12.0		85 15		.52	8	12.0		85 21		.50	9	10.2
82	12	15.0		41		.53	42	15.0		46		.53	13	15.0		51		.52	8	9.0
83	16	15.0		86 13		.53	46	15.0		86 18		.52	17	20.0		86 22		.52	7	7.9
84	20	20.0		45		.53	50	20.0		49		.53	20	20.0		53		.52	6	6.8
85	23	30.0		87 17		0.55	53	20.0		87 21		0.52	23	20.0		87 24		0.52	5	5.7
86	25	30.0		50		.53	56	30.0		52		.53	26	30.0		55		.52	4	4.5
87	27	30.0		88 22		.55	58	60.0		88 24		.53	28	60.0		88 26		.53	3	3.4
88	29	60.0		55		.53	59	60.0		56		.53	29	60.0		58		.52	2	2.3
89	30	—		89 27		.55	28 0	—		89 28		.53	30	—		89 29		.52	1	1.1
90	30			90 0			0			90 0			30			90 0			0	0.0
t	a	60′/Δ		b		Δ/60′	a	60′/Δ		b		Δ/60′	a	60′/Δ		b		Δ/60′		a
	d = 61° 30′						d = 62° 0′						d = 62° 30′							

b / B	a = 63° 0′						a = 63° 30′						a = 64° 0′						c / C	a / β
	h \ d	d	60′/Δ	Z \ t	t	Δ/60′	h \ d	d	60′/Δ	Z \ t	t	Δ/60′	h \ d	d	60′/Δ	Z \ t	t	Δ/60′		
0	0 0		2.22	63 0		0.00	0 0		2.22	63 30		0.00	0 0		2.31	64 0		0.00	90	90.0
1		27	2.22		0	.02		27	2.22		30	.02		26	2.22		0	.02	89	89.1
2		54	2.14		1	.02		54	2.31		31	.02		53	2.31		1	.02	88	88.2
3	1 22		2.22		2	.02	1 20		2.22		32	.02	1 19		2.31		2	.02	87	87.3
4		49	2.22		3	.03		47	2.22		33	.03		45	2.31		3	.03	86	86.4
5	2 16		2.22		5	0.03	2 14		2.31		35	0.03	2 11		2.22		5	0.03	85	85.5
6		43	2.22		7	.05		40	2.22		37	.05		38	2.31		7	.05	84	84.6
7	3 10		2.22		10	.05	3 7		2.22		40	.05	3 4		2.31		10	.05	83	83.7
8		37	2.22		13	.07		34	2.31		43	.07		30	2.31		13	.07	82	82.8
9	4 4		2.22		17	.07	4 0		2.22		47	.07		56	2.31		17	.07	81	81.9
10		31	2.22		21	0.08		27	2.31		51	0.07	4 22		2.31		21	0.07	80	81.0
11		58	2.22		26	.08		53	2.22		55	.08		48	2.31		25	.08	79	80.1
12	5 25		2.22		31	.08	5 20		2.31	64 0		.08	5 14		2.31		30	.08	78	79.2
13		52	2.31		36	.10		46	2.31		5	.10		40	2.40		35	.08	77	78.3
14	6 18		2.22		42	.10	6 12		2.31		11	.10	6 5		2.31		40	.10	76	77.4
15		45	2.31		48	0.10		38	2.31		17	0.12		31	2.40		46	0.12	75	76.5
16	7 11		2.22		54	.12	7 4		2.31		24	.12		56	2.31		53	.12	74	75.6
17		38	2.31	64 1		.13		30	2.31		31	.12	7 22		2.40	65 0		.12	73	74.7
18	8 4		2.31		9	.13		56	2.40		38	.13		47	2.40		7	.13	72	73.8
19		30	2.31		17	.13	8 21		2.31		46	.13	8 12		2.40		15	.13	71	72.9
20	56		2.31		25	0.15		47	2.40		54	0.13		37	2.40		23	0.13	70	72.0
21	9 22		2.31		34	.15	9 12		2.40	65 2		.15	9 2		2.40		31	.15	69	71.0
22		48	2.40		43	.15		37	2.40		11	.17		27	2.40		40	.15	68	70.1
23	10 13		2.31		52	.17	10 2		2.40		21	.17		52	2.50		49	.17	67	69.2
24		39	2.40	65 2		.18		27	2.40		31	.17	10 16		2.40		59	.17	66	68.3
25	11 4		2.40		13	0.18		52	2.40		41	0.18		41	2.50		66 9	0.18	65	67.3
26		29	2.40		24	.18	11 17		2.50		52	.18	11 5		2.50		20	.18	64	66.4
27		54	2.40		35	.20		41	2.50	66 3		.18		29	2.50		31	.18	63	65.5
28	12 19		2.50		47	.20	12 5		2.50		14	.20		53	2.61		42	.20	62	64.6
29		43	2.50		59	.20		29	2.50		26	.22	12 16		2.50		54	.20	61	63.6
30	13 7		2.50	66 11		0.22		53	2.50		39	0.22		40	2.61	67 6		0.22	60	62.7
31		31	2.50		24	.23	13 17		2.50		52	.22	13 3		2.61		19	.22	59	61.7
32		55	2.50		38	.23		41	2.61	67 5		.23		26	2.61		32	.22	58	60.8
33	14 19		2.50		52	.23	14 4		2.61		19	.23		49	2.61		45	.23	57	59.8
34		43	2.61	67 6		.25		27	2.61		33	.23	14 12		2.73		59	.23	56	58.9
35	15 6		2.61		21	0.25		50	2.73		47	0.25		34	2.73	68 13		0.25	55	57.9
36		29	2.61		36	.25	15 12		2.73	68 2		.25		56	2.73		28	.25	54	57.0
37		52	2.73		51	.27		34	2.73		17	.27	15 18		2.73		43	.27	53	56.0
38	16 14		2.73	68 7		.28		56	2.73		33	.27		40	2.86		59	.27	52	55.0
39		36	2.73		24	.28	16 18		2.73		49	.28	16 1		2.86	69 15		.27	51	54.1
40		58	2.73		41	0.28		40	2.86	69 6		0.28		22	2.86		31	0.28	50	53.1
41	17 20		2.86		58	.30	17 1		2.86		23	.28		43	2.86		48	.28	49	52.1
42		41	2.86	69 16		.30		22	2.86		40	.30	17 4		3.00	70 5		.28	48	51.1
43	18 2		2.86		34	.30		43	3.00		58	.30		24	3.00		22	.30	47	50.2
44		23	2.86		52	.32	18 3		3.00	70 16		.32		44	3.00		40	.30	46	49.2
45		44		70 11				23			35		18 4				58		45	48.2
t	a	60′/Δ	b	Δ/60′			a	60′/Δ	b	Δ/60′			a	60′/Δ	b	Δ/60′				a
	d = 63° 0′						d = 63° 30′						d = 64° 0′							

b / B	a = 63° 0′						a = 63° 30′						a = 64° 0′						c / C	a / β
	h \ d	60′/Δ		Z \ t		Δ/60′	h \ d	60′/Δ		Z \ t		Δ/60′	h \ d	60′/Δ		Z \ t		Δ/60′		
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
45	18 44	3.00		70 11		0.32	18 23	3.00		70 35		0.32	18 4	3.16		70 58		0.32	45	48.2
46	19 4	3.00			30	.33		43	3.00		54	.32		23	3.16		71 17	.32	44	47.2
47		24	3.16		50	.33	19 3		3.16	71 13		.33		42	3.16		36	.32	43	46.2
48		43	3.16	71 10		.35		22	3.16		33	.33	19 1		3.33		55	.33	42	45.2
49	20 2		3.16		31	.35		41	3.33		53	.35		19	3.33	72 15		.35	41	44.2
50		21	3.16		52	0.35		59	3.33	72 14		0.35		37	3.33		36	0.33	40	43.2
51		40	3.33	72 13		.37	20 17		3.33		35	.35		55	3.53		56	.35	39	42.1
52		58	3.33		35	.37		35	3.53		56	.37	20 12		3.53	73 17		.35	38	41.1
53	21 16		3.53		57	.38		52	3.53	73 18		.37		29	3.53		38	.37	37	40.1
54		33	3.53	73 20		.38	21 9		3.53		40	.37		46	3.53	74 0		.37	36	39.1
55		50	3.53		43	0.38		26	3.75	74 2		0.38	21 3		3.75		22	0.38	35	38.0
56	22 7		3.75	74 6		.40		42	3.75		25	.38		19	4.00		45	.37	34	37.0
57		23	3.75		30	.40		58	3.75		48	.40		34	4.00	75 7		.38	33	36.0
58		39	4.00		54	.40	22 14		4.00	75 12		.40		49	4.00		30	.40	32	34.9
59		54	4.00	75 18		.40		29	4.00		36	.40	22 4		4.00		54	.40	31	33.9
60	23 9		4.00		42	0.42		44	4.29	76 0		0.42		19	4.29	76 18		0.40	30	32.8
61		24	4.29	76 7		.43		58	4.29		25	.42		33	4.62		42	.40	29	31.8
62		38	4.29		33	.43	23 12		4.29		50	.42		46	4.62	77 6		.42	28	30.7
63		52	4.62		59	.43		26	4.62	77 15		.42		59	4.62		31	.42	27	29.7
64	24 5		4.62	77 25		.43		39	5.00		40	.43	23 12		5.00		56	.42	26	28.6
65		18	5.00		51	0.45		51	5.00	78 6		0.43		24	5.00	78 21		0.43	25	27.5
66		30	5.00	78 18		.45	24 3		5.00		32	.43		36	5.00		47	.43	24	26.5
67		42	5.00		45	.45		15	5.45		58	.45		48	5.45	79 13		.43	23	25.4
68		54	5.45	79 12		.45		26	5.45	79 25		.45		59	5.45		39	.43	22	24.3
69	25 5		6.00		39	.47		37	6.00		52	.45	24 10		6.00	80 5		.45	21	23.2
70		15	6.00	80 7		0.47		47	6.00	80 19		0.47		20	6.67		32	0.45	20	22.1
71		25	6.00		35	.47		57	6.00		47	.47		29	6.67		59	.45	19	21.0
72		35	6.67	81 3		.48	25 7		6.67	81 15		.47		38	6.67	81 26		.45	18	20.0
73		44	6.67		32	.47		16	7.50		43	.47		47	7.50		53	.45	17	18.9
74		53	7.50	82 0		.48		24	7.50	82 11		.47		55	7.50	82 20		.47	16	17.8
75	26 1		8.57		29	0.48		32	8.57		39	0.47	25 3		8.57		48	0.47	15	16.7
76		8	8.57		58	.50		39	8.57	83 7		.48		10	8.57	83 16		.47	14	15.6
77		15	8.57	83 28		.48		46	8.57		36	.48		17	10.0		44	.48	13	14.5
78		22	10.0		57	.50		53	10.0	84 5		.48		23	10.0	84 13		.47	12	13.4
79		28	12.0	84 27		.50		59	12.0		34	.48		29	12.0		41	.47	11	12.3
80		33	12.0		57	0.50	26 4		12.0	85 3		0.48		34	12.0	85 9		0.48	10	11.1
81		38	12.0	85 27		.50		9	15.0		32	.50		39	15.0		38	.48	9	10.0
82		43	15.0		57	.50		13	15.0	86 2		.48		43	15.0	86 7		.48	8	8.9
83		47	20.0	86 27		.50		17	15.0		31	.50		47	15.0		36	.48	7	7.8
84		50	20.0		57	.50		21	20.0	87 1		.50		51	20.0	87 5		.48	6	6.7
85		53	20.0	87 27		0.52		24	30.0		31	0.48		54	30.0		34	0.48	5	5.6
86		56	30.0		58	.50		26	30.0	88 0		.50		56	30.0	88 3		.48	4	4.5
87		58	60.0	88 28		.52		28	60.0		30	.50		58	60.0		32	.48	3	3.4
88		59	60.0		59	.50		29	60.0	89 0		.50		59	60.0	89 1		.50	2	2.2
89	27 0		—	89 29		.52		30	—		30	.50	26 0		—		31	.48	1	1.1
90		0		90 0				30		90 0				0		90 0			0	0.0
t	a	60′/Δ		b		Δ/60′	a	60′/Δ		b		Δ/60′	a	60′/Δ		b		Δ/60′		a
	d = 63° 0′						d = 63° 30′						d = 64° 0′							

b / B	a = 64° 30′						a = 65° 0′						a = 65° 30′						c / C	a / β
	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′		
°	°	′		°	′		°	′		°	′		°	′		°	′		°	°
0	0	0	2.31	64	30	0.00	0	0	2.40	65	0	0.00	0	0	2.40	65	30	0.00	90	90.0
1		26	2.31		30	.02		25	2.31		0	.02		25	2.40		30	.02	89	89.1
2		52	2.31		31	.02		51	2.40		1	.02		50	2.40		31	.02	88	88.2
3	1	18	2.40		32	.02	1	16	2.40		2	.02	1	15	2.50		32	.02	87	87.3
4		43	2.31		33	.03		41	2.31		3	.03		39	2.40		33	.03	86	86.4
5	2	9	2.31		35	0.03	2	7	2.40		5	0.03	2	4	2.40		35	0.03	85	85.5
6		35	2.40		37	.05		32	2.40		7	.05		29	2.40		37	.05	84	84.6
7	3	0	2.31		40	.05		57	2.40		10	.05		54	2.40		40	.05	83	83.7
8		26	2.31		43	.05	3	22	2.40		13	.05	3	19	2.50		43	.05	82	82.7
9		52	2.40		46	.07		47	2.40		16	.07		43	2.40		46	.07	81	81.8
10	4	17	2.31		50	0.07	4	12	2.40		20	0.07	4	8	2.50		50	0.07	80	80.9
11		43	2.40		54	.08		37	2.40		24	.08		32	2.40		54	.07	79	80.0
12	5	8	2.40		59	.08	5	2	2.40		29	.08		57	2.50		58	.08	78	79.1
13		33	2.31	65	4	.10		27	2.40		34	.08	5	21	2.50	66	3	.10	77	78.2
14		59	2.40		10	.10		52	2.40		39	.10		45	2.40		9	.10	76	77.3
15	6	24	2.40		16	0.10	6	17	2.50		45	0.10	6	10	2.50		15	0.10	75	76.4
16		49	2.40		22	.12		41	2.40		51	.12		34	2.50		21	.10	74	75.4
17	7	14	2.40		29	.12	7	6	2.50		58	.12		58	2.50		27	.12	73	74.5
18		39	2.40		36	.13		30	2.50	66	5	.12	7	22	2.50		34	.12	72	73.6
19	8	4	2.50		44	.13		54	2.50		12	.13		46	2.61		41	.13	71	72.7
20		28	2.40		52	0.13	8	18	2.50		20	0.13	8	9	2.50		49	0.13	70	71.7
21		53	2.50	66	0	.15		42	2.50		28	.15		33	2.61		57	.15	69	70.8
22	9	17	2.50		9	.15	9	6	2.50		37	.15		56	2.61	67	6	.15	68	69.9
23		41	2.50		18	.15		30	2.50		46	.17	9	19	2.61		15	.15	67	69.0
24	10	5	2.50		27	.17		54	2.61		56	.17		42	2.61		24	.17	66	68.0
25		29	2.50		37	0.18	10	17	2.50	67	6	0.17	10	5	2.61		34	0.17	65	67.1
26		53	2.50		48	.18		41	2.61		16	.17		28	2.61		44	.17	64	66.2
27	11	17	2.61		59	.18	11	4	2.61		26	.18		51	2.61		54	.18	63	65.2
28		40	2.61	67	10	.18		27	2.61		37	.20	11	14	2.73	68	5	.18	62	64.3
29	12	3	2.61		21	.20		50	2.73		49	.20		36	2.73		16	.20	61	63.3
30		26	2.61		33	0.22	12	12	2.73	68	1	0.20		58	2.73		28	0.20	60	62.4
31		49	2.73		46	.22		34	2.73		13	.20	12	20	2.73		40	.20	59	61.4
32	13	11	2.61		59	.22		56	2.73		25	.22		42	2.86		52	.22	58	60.5
33		34	2.73	68	12	.23	13	18	2.73		38	.23	13	3	2.86	69	5	.22	57	59.5
34		56	2.73		26	.23		40	2.73		52	.23		24	2.86		18	.23	56	58.6
35	14	18	2.73		40	0.23	14	2	2.86	69	6	0.23		45	2.86		32	0.23	55	57.6
36		40	2.86		54	.25		23	2.86		20	.23	14	6	2.86		46	.23	54	56.6
37	15	1	2.86	69	9	.25		44	2.86		34	.25		27	2.86	70	0	.25	53	55.7
38		22	2.86		24	.27	15	5	2.86		49	.27		48	3.00		15	.25	52	54.7
39		43	2.86		40	.27		26	3.00	70	5	.27	15	8	3.00		30	.25	51	53.7
40	16	4	3.00		56	0.27		46	3.00		21	0.27		28	3.16		45	0.27	50	52.7
41		24	3.00	70	12	.28	16	6	3.00		37	.27		47	3.16	71	1	.27	49	51.8
42		44	3.00		29	.28		26	3.16		53	.28	16	6	3.16		17	.28	48	50.8
43	17	4	3.00		46	.30		45	3.16	71	10	.28		25	3.16		34	.28	47	49.8
44		24	3.16	71	4	.30	17	4	3.16		27	.30		44	3.16		51	.28	46	48.8
45		43			22			23			45		17	3		72	8		45	47.8

t	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′		a
	d = 64° 30′				d = 65° 0′				d = 65° 30′					

b / B	$a = 64° 30'$						$a = 65° 0'$						$a = 65° 30'$						c / C	a / β
	d / h	60′/Δ		t / Z	Δ/60′		d / h	60′/Δ		t / Z	Δ/60′		d / h	60′/Δ		t / Z	Δ/60′			
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
45	17 43	3.16		71 22	0.30		17 23	3.16		71 45	0.30		17 3	3.33		72 8	0.30		45	47.8
46	18 2	3.16		40	.32		42	3.33		72 3	.30		21	3.33		26	.30		44	46.8
47	21	3.16		59	.32		18 0	3.33		21	.32		39	3.33		44	.30		43	45.8
48	40	3.33		72 18	.32		18	3.33		40	.32		57	3.53		73 2	.32		42	44.8
49	58	3.33		37	.33		36	3.53		59	.33		18 14	3.53		21	.32		41	43.8
50	19 16	3.53		57	0.33		53	3.53		73 19	0.33		31	3.53		40	0.33		40	42.8
51	33	3.53		73 17	.35		19 10	3.53		39	.33		48	3.75		74 0	.33		39	41.8
52	50	3.53		38	.35		27	3.75		59	.33		19 4	3.75		20	.33		38	40.8
53	20 7	3.75		59	.35		43	3.75		74 19	.35		20	3.75		40	.33		37	39.7
54	23	3.75		74 20	.37		59	3.75		40	.35		36	3.75		75 0	.35		36	38.7
55	39	3.75		42	0.37		20 15	4.00		75 1	0.37		52	4.00		21	0.35		35	37.7
56	55	4.00		75 4	.37		30	4.00		23	.37		20 7	4.29		42	.37		34	36.7
57	21 10	4.00		26	.38		45	4.00		45	.37		21	4.29		76 4	.37		33	35.6
58	25	4.29		49	.38		21 0	4.29		76 7	.38		35	4.29		26	.37		32	34.6
59	39	4.29		76 12	.38		14	4.29		30	.38		49	4.29		48	.37		31	33.5
60	53	4.29		35	0.40		28	4.29		53	0.38		21 3	4.62		77 10	0.37		30	32.5
61	22 7	4.62		59	.40		42	4.62		77 16	.38		16	4.62		32	.38		29	31.5
62	20	4.62		77 23	.40		55	5.00		39	.40		29	5.00		55	.40		28	30.4
63	33	4.62		47	.40		22 7	5.00		78 3	.40		41	5.00		78 19	.38		27	29.3
64	46	5.00		78 11	.42		19	5.00		27	.40		53	5.00		42	.40		26	28.3
65	58	5.00		36	0.42		31	5.00		51	0.42		22 5	5.45		79 6	0.40		25	27.2
66	23 10	5.45		79 1	.42		43	5.45		79 16	.42		16	5.45		30	.40		24	26.2
67	21	5.45		26	.43		54	6.00		41	.42		27	6.00		54	.42		23	25.1
68	32	6.00		52	.43		23 4	6.00		80 6	.42		37	6.00		80 19	.42		22	24.0
69	42	6.00		80 18	.43		14	6.00		31	.42		47	6.67		44	.42		21	23.0
70	52	6.67		44	0.43		24	6.67		56	0.43		56	6.67		81 9	0.42		20	21.9
71	24 1	6.67		81 10	.45		33	6.67		81 22	.43		23 5	6.67		34	.42		19	20.8
72	10	6.67		37	.45		42	7.50		48	.43		14	7.50		59	.43		18	19.7
73	19	7.50		82 4	.45		50	7.50		82 14	.43		22	7.50		82 25	.43		17	18.6
74	27	8.57		31	.45		58	7.50		40	.45		30	8.57		51	.43		16	17.6
75	34	8.57		58	0.45		24 6	8.57		83 7	0.45		37	8.57		83 17	0.43		15	16.5
76	41	8.57		83 25	.45		13	10.0		34	.45		44	10.0		43	.43		14	15.4
77	48	10.0		52	.47		19	10.0		84 1	.45		50	10.0		84 9	.43		13	14.3
78	54	10.0		84 20	.47		25	10.0		28	.45		56	12.0		35	.45		12	13.2
79	25 0	12.0		48	.47		31	12.0		55	.45		24 1	12.0		85 2	.45		11	12.1
80	5	12.0		85 16	0.47		36	15.0		85 22	0.47		6	12.0		29	0.43		10	11.0
81	10	15.0		44	.47		40	15.0		50	.45		11	15.0		55	.45		9	9.9
82	14	15.0		86 12	.47		44	15.0		86 17	.47		15	20.0		86 22	.45		8	8.8
83	18	20.0		40	.48		48	20.0		45	.45		18	20.0		49	.45		7	7.7
84	21	20.0		87 9	.47		51	20.0		87 12	.47		21	20.0		87 16	.47		6	6.6
85	24	30.0		37	0.48		54	30.0		40	0.47		24	30.0		44	0.45		5	5.5
86	26	30.0		88 6	.47		56	30.0		88 8	.47		26	30.0		88 11	.45		4	4.4
87	28	60.0		34	.48		58	60.0		36	.47		28	60.0		38	.45		3	3.3
88	29	60.0		89 3	.47		59	60.0		89 4	.47		29	60.0		89 5	.47		2	2.2
89	30	—		31	.48		25 0	—		32	.47		30	—		33	.45		1	1.1
90	30			90 0			0			90 0			30			90 0			0	0.0
t	a	60′/Δ		b	Δ/60′		a	60′/Δ		b	Δ/60′		a	60′/Δ		b	Δ/60′			a
	$d = 64° 30'$						$d = 65° 0'$						$d = 65° 30'$							

b / B	a = 66° 0′						a = 66° 30′						a = 67° 0′						c / C	a / β
	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′	h \ d		60′/Δ	Z \ t		Δ/60′		
°	°	′		°	′		°	′		°	′		°	′		°	′		°	°
0	0	0	2.50	66	0	0.00	0	0	2.50	66	30	0.00	0	0	2.61	67	0	0.00	90	90.0
1		24	2.40		0	.02		24	2.50		30	.02		23	2.50		0	.02	89	89.1
2		49	2.50		1	.02		48	2.50		31	.02		47	2.61		1	.02	88	88.2
3	1	13	2.40		2	.02	1	12	2.50		32	.02	1	10	2.50		2	.02	87	87.2
4		38	2.50		3	.03		36	2.50		33	.03		34	2.61		3	.03	86	86.3
5	2	2	2.50		5	0.03	2	0	2.61		35	0.03		57	2.61		5	0.03	85	85.4
6		26	2.50		7	.03		23	2.50		37	.03	2	20	2.50		7	.03	84	84.5
7		50	2.40		9	.05		47	2.50		39	.05		44	2.61		9	.05	83	83.6
8	3	15	2.50		12	.07	3	11	2.50		42	.05	3	7	2.61		12	.05	82	82.7
9		39	2.50		16	.07		35	2.61		45	.07		30	2.61		15	.07	81	81.7
10	4	3	2.50		20	0.07		58	2.50		49	0.07		53	2.61		19	0.07	80	80.8
11		27	2.50		24	.07	4	22	2.61		53	.07	4	16	2.61		23	.07	79	79.9
12		51	2.50		28	.08		45	2.50		57	.08		39	2.61		27	.08	78	79.0
13	5	15	2.50		33	.08	5	9	2.61	67	2	.08	5	2	2.61		32	.08	77	78.0
14		39	2.50		38	.10		32	2.61		7	.10		25	2.61		37	.08	76	77.1
15	6	3	2.61		44	0.10		55	2.61		13	0.10		48	2.61		42	0.10	75	76.2
16		26	2.50		50	.10	6	18	2.61		19	.10	6	11	2.61		48	.10	74	75.3
17		50	2.61		56	.12		41	2.61		25	.12		34	2.73		54	.12	73	74.3
18	7	13	2.50	67	3	.12	7	4	2.61		32	.12		56	2.61	68	1	.12	72	73.4
19		37	2.61		10	.13		27	2.61		39	.12	7	19	2.73		8	.12	71	72.5
20	8	0	2.61		18	0.13		50	2.61		46	0.13		41	2.73		15	0.13	70	71.5
21		23	2.61		26	.13	8	13	2.61		54	.13	8	3	2.73		23	.13	69	70.6
22		46	2.61		34	.15		36	2.73	68	2	.15		25	2.73		31	.13	68	69.7
23	9	9	2.73		43	.15		58	2.73		11	.15		47	2.73		39	.15	67	68.7
24		31	2.61		52	.17	9	20	2.73		20	.15	9	9	2.86		48	.15	66	67.8
25		54	2.73	68	2	0.17		42	2.73		29	0.17		30	2.73		57	0.17	65	66.8
26	10	16	2.73		12	.17	10	4	2.73		39	.17		52	2.86	69	7	.17	64	65.9
27		38	2.73		22	.17		26	2.73		49	.18	10	13	2.86		17	.17	63	65.0
28	11	0	2.73		32	.18		48	2.86	69	0	.18		34	2.86		27	.18	62	64.0
29		22	2.73		43	.20	11	9	2.86		11	.18		55	2.86		38	.18	61	63.1
30		44	2.73		55	0.20		30	2.86		22	0.20	11	16	2.86		49	0.18	60	62.1
31	12	6	2.86	69	7	.20		51	2.86		34	.20		37	3.00	70	0	.20	59	61.1
32		27	2.86		19	.20	12	12	2.86		46	.20		57	3.00		12	.20	58	60.2
33		48	2.86		31	.22		33	3.00		58	.22	12	17	3.00		24	.22	57	59.2
34	13	9	2.86		44	.23		53	3.00	70	11	.22		37	3.00		37	.22	56	58.3
35		30	3.00		58	0.23	13	13	3.00		24	0.22		57	3.00		50	0.22	55	57.3
36		50	3.00	70	12	.23		33	3.00		37	.23	13	17	3.16	71	3	.22	54	56.3
37	14	10	3.00		26	.23		53	3.00		51	.23		36	3.16		16	.23	53	55.4
38		30	3.00		40	.25	14	13	3.16	71	5	.25		55	3.16		30	.23	52	54.4
39		50	3.16		55	.25		32	3.16		20	.25	14	14	3.16		44	.25	51	53.4
40	15	9	3.16	71	10	0.27		51	3.16		35	0.25		33	3.33		59	0.25	50	52.4
41		28	3.16		26	.27	15	10	3.16		50	.27		51	3.33	72	14	.25	49	51.4
42		47	3.16		42	.27		29	3.33	72	6	.27	15	9	3.33		29	.27	48	50.5
43	16	6	3.16		58	.27		47	3.33		22	.27		27	3.33		45	.27	47	49.5
44		25	3.33	72	14	.28	16	5	3.33		38	.28		45	3.53	73	1	.28	46	48.5
45		43			31			23			55		16	2			18		45	47.5
t	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′		a
	d = 66° 0′						d = 66° 30′						d = 67° 0′							

b / B	a = 66° 0′						a = 66° 30′						a = 67° 0′						c / C	a / β
	h \ d	60′/Δ	Δ/60′	Z \ t		Δ/60′	h \ d	60′/Δ	Δ/60′	Z \ t		Δ/60′	h \ d	60′/Δ	Δ/60′	Z \ t		Δ/60′		
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
45	16 43	3.33		72 31		0.30	16 23	3.53		72 55		0.28	16 2	3.53		73 18		0.27	45	47.5
46	17 1	3.53			49	.30		40	3.53	73 12		.28		19	3.53		34	.28	44	46.5
47		18	3.53	73	7	.30		57	3.53		29	.30		36	3.53		51	.28	43	45.5
48		35	3.53		25	.30	17 14		3.53		47	.30		53	3.75	74	8	.30	42	44.5
49		52	3.53		43	.32		31	3.75	74	5	.30	17 9		3.75		26	.30	41	43.5
50	18 9	3.75		74 2		0.32		47	3.75		23	0.32		25	3.75		44	0.32	40	42.5
51		25	3.75		21	.32	18 3		3.75		42	.32		41	4.00	75	3	.30	39	41.4
52		41	3.75		40	.33		19	4.00	75	1	.32		56	4.00		21	.32	38	40.4
53		57	3.75	75	0	.33		34	4.00		20	.33	18 11		4.00		40	.32	37	39.4
54	19 13		4.00		20	.33		49	4.00		40	.33		26	4.29		59	.33	36	38.4
55		28	4.00		40	0.35	19 4		4.29	76	0	0.33		40	4.29	76	19	0.33	35	37.4
56		43	4.29	76	1	.35		18	4.29		20	.35		54	4.29		39	.33	34	36.3
57		57	4.29		22	.35		32	4.29		41	.35	19 8		4.62		59	.33	33	35.3
58	20 11		4.62		43	.37		46	4.62	77	2	.35		21	4.62	77	19	.35	32	34.3
59		24	4.62	77	5	.37		59	4.62		23	.35		34	4.62		40	.35	31	33.2
60		37	4.62		27	0.37	20 12		4.62		44	0.37		47	5.00	78	1	0.35	30	32.2
61		50	4.62		49	.37		25	5.00	78	6	.37		59	5.00		22	.37	29	31.2
62	21 3		5.00	78	11	.38		37	5.00		28	.37	20 11		5.00		44	.37	28	30.1
63		15	5.00		34	.38		49	5.45		50	.37		23	5.45	79	6	.37	27	29.1
64		27	5.45		57	.38	21 0		5.45	79	12	.38		34	5.45		28	.37	26	28.0
65		38	5.45	79	20	0.40		11	5.45		35	0.38		45	6.00		50	0.37	25	27.0
66		49	6.00		44	.40		22	6.00		58	.38		55	6.00	80	12	.38	24	25.9
67		59	6.00	80	8	.40		32	6.00	80	21	.40	21 5		6.00		35	.38	23	24.8
68	22 9		6.00		32	.40		42	6.67		45	.40		15	6.67		58	.38	22	23.8
69		19	6.67		56	.40		51	6.67	81	9	.40		24	6.67	81	21	.38	21	22.7
70		28	6.67	81	20	0.42	22 0		6.67		33	0.40		33	7.50		44	0.40	20	21.6
71		37	7.50		45	.42		9	7.50		57	.40		41	7.50	82	8	.40	19	20.6
72		45	7.50	82	10	.42		17	7.50	82	21	.40		49	7.50		32	.40	18	19.5
73		53	7.50		35	.42		25	8.57		45	.42		57	8.57		56	.40	17	18.4
74	23 1		8.57	83	0	.43		32	8.57	83	10	.42	22 4		8.57	83	20	.40	16	17.4
75		8	8.57		26	0.42		39	8.57		35	0.42		11	10.0		44	0.40	15	16.3
76		15	10.0		51	.43		46	10.0	84	0	.42		17	10.0	84	8	.42	14	15.2
77		21	10.0	84	17	.43		52	10.0		25	.42		23	12.0		33	.40	13	14.1
78		27	12.0		43	.43		58	12.0		50	.42		28	12.0		57	.42	12	13.1
79		32	12.0	85	9	.43	23 3		12.0	85	15	.43		33	12.0	85	22	.42	11	12.0
80		37	15.0		35	0.43		8	15.0		41	0.42		38	15.0		47	0.42	10	10.9
81		41	15.0	86	1	.43		12	15.0	86	6	.43		42	15.0	86	12	.42	9	9.8
82		45	15.0		27	.45		16	20.0		32	.43		46	20.0		37	.42	8	8.7
83		49	20.0		54	.43		19	20.0		58	.43		49	20.0	87	2	.43	7	7.6
84		52	30.0	87	20	.45		22	30.0	87	24	.43		52	30.0		28	.42	6	6.5
85		54	30.0		47	0.43		24	30.0		50	0.43		54	30.0		53	0.42	5	5.5
86		56	30.0	88	13	.45		26	30.0	88	16	.43		56	30.0	88	18	.43	4	4.4
87		58	60.0		40	.45		28	60.0		42	.43		58	60.0		44	.42	3	3.3
88		59	60.0	89	7	.43		29	60.0	89	8	.43		59	60.0	89	9	.42	2	2.2
89	24 0		—		33	.45		30	—		34	.43	23 0		—		34	.43	1	1.1
90		0		90	0			30		90	0			0		90	0		0	0.0
t	a	60′/Δ	Δ/60′	b			a	60′/Δ	Δ/60′	b			a	60′/Δ	Δ/60′	b				a
	d = 66° 0′						d = 66° 30′						d = 67° 0′							

b / B	a = 67° 30′						a = 68° 0′						a = 68° 30′						c / C	a / β
	h \ d	60′/Δ		Z \ t		Δ/60′	h \ d	60′/Δ		Z \ t		Δ/60′	h \ d	60′/Δ		Z \ t		Δ/60′		
	° ′			° ′			° ′			° ′			° ′			° ′				
0	0 0	2.61		67 30		0.00	0 0	2.73		68 0		0.00	0 0	2.73		68 30		0.00	90	90.0
1	23	2.61		30		.02	22	2.61		0		.02	22	2.73		30		.02	89	89.1
2	46	2.61		31		.02	45	2.73		1		.02	44	2.73		31		.02	88	88.1
3	1 9	2.61		32		.02	1 7	2.61		2		.02	1 6	2.73		32		.02	87	87.2
4	32	2.61		33		.03	30	2.73		3		.03	28	2.73		33		.03	86	86.3
5	55	2.61		35		0.03	52	2.61		5		0.03	50	2.73		35		0.03	85	85.4
6	2 18	2.73		37		.03	2 15	2.73		7		.03	2 12	2.73		37		.03	84	84.4
7	40	2.61		39		.05	37	2.73		9		.05	34	2.86		39		.03	83	83.5
8	3 3	2.61		42		.05	59	2.61		12		.05	55	2.73		41		.05	82	82.6
9	26	2.61		45		.05	3 22	2.73		15		.05	3 17	2.73		44		.07	81	81.6
10	49	2.73		48		0.07	44	2.73		18		0.07	39	2.73		48		0.07	80	80.7
11	4 11	2.61		52		.07	4 6	2.73		22		.07	4 1	2.86		52		.07	79	79.8
12	34	2.73		56		.08	28	2.73		26		.08	22	2.73		56		.07	78	78.9
13	56	2.61		68 1		.08	50	2.73		31		.08	44	2.86		69 0		.08	77	77.9
14	5 19	2.73		6		.10	5 12	2.73		36		.08	5 5	2.73		5		.08	76	77.0
15	41	2.73		12		0.10	34	2.73		41		0.10	27	2.86		10		0.10	75	76.0
16	6 3	2.73		18		.10	56	2.86		47		.10	48	2.86		16		.10	74	75.1
17	25	2.73		24		.10	6 17	2.73		53		.10	6 9	2.86		22		.10	73	74.2
18	47	2.73		30		.12	39	2.86		59		.12	30	2.86		28		.10	72	73.2
19	7 9	2.73		37		.12	7 0	2.73		69 6		.12	51	2.86		34		.12	71	72.3
20	31	2.73		44		0.13	22	2.86		13		0.12	7 12	2.86		41		0.12	70	71.4
21	53	2.73		52		.13	43	2.86		20		.13	33	2.86		48		.13	69	70.4
22	8 15	2.86		69 0		.13	8 4	2.86		28		.13	54	3.00		56		.13	68	69.5
23	36	2.86		8		.13	25	2.86		36		.13	8 14	3.00		70 4		.13	67	68.5
24	57	2.86		16		.15	46	2.86		44		.15	34	3.00		12		.15	66	67.6
25	9 18	2.86		25		0.17	9 7	3.00		53		0.15	54	3.00		21		0.15	65	66.6
26	39	2.86		35		.17	27	2.86		70 2		.17	9 14	3.00		30		.15	64	65.7
27	10 0	2.86		45		.17	48	3.00		12		.17	34	3.00		39		.17	63	64.7
28	21	2.86		55		.17	10 8	3.00		22		.17	54	3.00		49		.17	62	63.8
29	42	3.00		70 5		.18	28	3.00		32		.18	10 14	3.00		59		.18	61	62.8
30	11 2	3.00		16		0.18	48	3.00		43		0.18	34	3.16		71 10		0.18	60	61.8
31	22	3.00		27		.20	11 8	3.16		54		.18	53	3.16		21		.18	59	60.9
32	42	3.00		39		.20	27	3.16		71 5		.20	11 12	3.16		32		.18	58	59.9
33	12 2	3.00		51		.20	46	3.16		17		.20	31	3.16		43		.20	57	58.9
34	22	3.16		71 3		.20	12 5	3.16		29		.20	50	3.33		55		.20	56	58.0
35	41	3.16		15		0.22	24	3.16		41		0.22	12 8	3.33		72 7		0.20	55	57.0
36	13 0	3.16		28		.22	43	3.16		54		.22	26	3.33		19		.22	54	56.0
37	19	3.16		41		.23	13 2	3.33		72 7		.22	44	3.33		32		.22	53	55.1
38	38	3.33		55		.23	20	3.33		20		.23	13 2	3.33		45		.23	52	54.1
39	56	3.33		72 9		.25	38	3.33		34		.23	20	3.33		59		.23	51	53.1
40	14 14	3.33		24		0.25	56	3.33		48		0.23	38	3.53		73 13		0.23	50	52.1
41	32	3.33		39		.25	14 14	3.53		73 2		.25	55	3.53		27		.23	49	51.1
42	50	3.33		54		.25	31	3.53		17		.25	14 12	3.53		41		.25	48	50.1
43	15 8	3.53		73 9		.27	48	3.53		32		.27	29	3.75		56		.25	47	49.2
44	25	3.53		25		.27	15 5	3.53		48		.25	45	3.75		74 11		.25	46	48.2
45	42			41			22			74 3			15 1			26			45	47.2
t	a	60′/Δ		b		Δ/60′	a	60′/Δ		b		Δ/60′	a	60′/Δ		b		Δ/60′		a
	d = 67° 30′						d = 68° 0′						d = 68° 30′							

b / B	a = 67° 30′						a = 68° 0′						a = 68° 30′						c / C	α / β
	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′		
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
45	15 42		3.53	73 41		0.27	15 22		3.75	74 3		0.27	15 1		3.75	74 26		0.27	45	47.2
46	59		3.75	57		.28	38		3.75	19		.28	17		3.75	42		.27	44	46.2
47	16 15		3.75	74 14		.28	54		3.75	36		.27	33		4.00	58		.27	43	45.2
48	31		3.75	31		.28	16 10		3.75	52		.28	48		4.00	75 14		.28	42	44.2
49	47		3.75	48		.30	26		4.00	75 9		.28	16 3		4.00	31		.28	41	43.2
50	17 3		4.00	75 6		0.30	41		4.00	26		0.30	18		4.00	48		0.28	40	42.1
51	18		4.00	24		.30	56		4.29	44		.30	33		4.29	76 5		.28	39	41.1
52	33		4.00	42		.30	17 10		4.29	76 2		.30	47		4.29	22		.30	38	40.1
53	48		4.29	76 0		.32	24		4.29	20		.30	17 1		4.29	40		.30	37	39.1
54	18 2		4.29	19		.32	38		4.29	38		.32	15		4.62	58		.30	36	38.1
55	16		4.29	38		0.32	52		4.29	57		0.32	28		4.62	77 16		0.32	35	37.1
56	30		4.62	57		.33	18 6		4.62	77 16		.32	41		4.62	35		.32	34	36.0
57	43		4.62	77 17		.33	19		4.62	35		.33	54		5.00	54		.32	33	35.0
58	56		4.62	37		.33	32		5.00	55		.33	18 6		5.00	78 13		.32	32	34.0
59	19 9		5.00	57		.35	44		5.00	78 15		.33	18		5.00	32		.32	31	32.9
60	21		5.00	78 18		0.35	56		5.00	35		0.33	30		5.00	51		0.33	30	31.9
61	33		5.00	39		.35	19 8		5.45	55		.35	42		5.45	79 11		.33	29	30.9
62	45		5.45	79 0		.35	19		5.45	79 16		.35	53		5.45	31		.33	28	29.8
63	56		5.45	21		.35	30		5.45	37		.35	19 4		6.00	51		.35	27	28.8
64	20 7		5.45	42		.37	41		6.00	58		.35	14		6.00	80 12		.35	26	27.7
65	18		6.00	80 4		0.37	51		6.00	80 19		0.35	24		6.00	33		0.35	25	26.7
66	28		6.00	26		.37	20 1		6.67	40		.37	34		6.67	54		.35	24	25.7
67	38		6.67	48		.38	10		6.67	81 2		.37	43		6.67	81 15		.35	23	24.6
68	47		6.67	81 11		.37	19		6.67	24		.37	52		6.67	36		.37	22	23.5
69	56		6.67	33		.38	28		6.67	46		.37	20 1		7.50	58		.37	21	22.5
70	21 5		7.50	56		0.38	37		7.50	82 8		0.37	9		7.50	82 20		0.37	20	21.4
71	13		7.50	82 19		.38	45		8.57	30		.38	17		8.57	42		.37	19	20.4
72	21		8.57	42		.40	52		8.57	53		.38	24		8.57	83 4		.37	18	19.3
73	28		8.57	83 6		.38	59		8.57	83 16		.38	31		8.57	26		.37	17	18.3
74	35		8.57	29		.40	21 6		8.57	39		.38	38		10.0	48		.38	16	17.2
75	42		10.0	53		0.40	13		10.0	84 2		0.38	44		10.0	84 11		0.37	15	16.1
76	48		10.0	84 17		.40	19		10.0	25		.38	50		12.0	33		.38	14	15.1
77	54		12.0	41		.40	25		12.0	48		.40	55		12.0	56		.38	13	14.0
78	59		12.0	85 5		.40	30		12.0	85 12		.40	21 0		12.0	85 19		.38	12	12.9
79	22 4		15.0	29		.40	35		15.0	36		.38	5		15.0	42		.38	11	11.8
80	8		15.0	53		0.40	39		15.0	59		0.40	9		15.0	86 5		0.38	10	10.8
81	12		15.0	86 17		.42	43		15.0	86 23		.40	13		15.0	28		.40	9	9.7
82	16		20.0	42		.42	47		20.0	47		.40	17		20.0	52		.38	8	8.6
83	19		20.0	87 7		.40	50		20.0	87 11		.40	20		20.0	87 15		.40	7	7.5
84	22		20.0	31		.42	53		30.0	35		.40	23		30.0	39		.38	6	6.5
85	25		30.0	56		0.42	55		30.0	59		0.40	25		30.0	88 2		0.40	5	5.4
86	27		60.0	88 21		.40	57		60.0	88 23		.40	27		60.0	26		.38	4	4.3
87	28		60.0	45		.42	58		60.0	47		.42	28		60.0	49		.40	3	3.2
88	29		60.0	89 10		.42	59		60.0	89 12		.40	29		60.0	89 13		.38	2	2.2
89	30		—	35		.42	22 0		—	36		.40	30		—	36		.40	1	1.1
90	30			90 0			0			90 0			30			90 0			0	0.0
t	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′		α
	d = 67° 30′						d = 68° 0′						d = 68° 30′							

b / B	a = 69° 0′						a = 69° 30′						a = 70° 0′						c / C	a / β
	h \ d	60′/Δ		Z \ t	Δ/60′		h \ d	60′/Δ		Z \ t	Δ/60′		h \ d	60′/Δ		Z \ t	Δ/60′			
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
0	0 0	2.73		69 0	0.00		0 0	2.86		69 30	0.00		0 0	2.86		70 0	0.00		90	90.0
1	22	2.86		0	.02		21	2.86		30	.02		21	3.00		0	.02		89	89.1
2	43	2.73		1	.02		42	2.86		31	.02		41	2.86		1	.02		88	88.1
3	1 5	2.86		2	.02		1 3	2.86		32	.02		1 2	3.00		2	.02		87	87.2
4	26	2.86		3	.02		24	2.86		33	.02		22	2.86		3	.02		86	86.3
5	47	2.73		4	0.03		45	2.86		34	0.03		43	3.00		4	0.03		85	85.3
6	2 9	2.86		6	.03		2 6	2.86		36	.03		2 3	3.00		6	.03		84	84.4
7	30	2.73		8	.05		27	2.86		38	.05		23	2.86		8	.05		83	83.4
8	52	2.86		11	.05		48	2.86		41	.05		44	3.00		11	.05		82	82.5
9	3 13	2.86		14	.05		3 9	3.00		44	.05		3 4	3.00		14	.05		81	81.6
10	34	2.86		17	0.07		29	2.86		47	0.07		24	2.86		17	0.05		80	80.6
11	55	2.86		21	.07		50	2.86		51	.07		45	3.00		20	.07		79	79.7
12	4 16	2.86		25	.07		4 11	3.00		55	.07		4 5	3.00		24	.07		78	78.7
13	37	2.86		29	.08		31	2.86		59	.08		25	3.00		28	.08		77	77.8
14	58	2.86		34	.08		52	3.00		70 4	.08		45	3.00		33	.08		76	76.8
15	5 19	2.86		39	0.10		5 12	2.86		9	0.08		5 5	3.00		38	0.08		75	75.9
16	40	2.86		45	.10		33	3.00		14	.10		25	3.16		43	.10		74	75.0
17	6 1	2.86		51	.10		53	3.00		20	.10		44	3.00		49	.10		73	74.0
18	22	3.00		57	.10		6 13	3.00		26	.10		6 4	3.00		55	.10		72	73.1
19	42	2.86		70 3	.12		33	3.00		32	.12		24	3.16		71 1	.10		71	72.1
20	7 3	3.00		10	0.12		53	3.00		39	0.12		43	3.00		7	0.12		70	71.2
21	23	3.00		17	.12		7 13	3.16		46	.12		7 3	3.16		14	.12		69	70.2
22	43	3.00		24	.13		32	3.00		53	.13		22	3.16		21	.13		68	69.3
23	8 3	3.00		32	.13		52	3.00		71 1	.13		41	3.16		29	.13		67	68.3
24	23	3.00		40	.15		8 12	3.16		9	.13		8 0	3.16		37	.13		66	67.4
25	43	3.16		49	0.15		31	3.16		17	0.15		19	3.16		45	0.13		65	66.4
26	9 2	3.00		58	.15		50	3.16		26	.15		38	3.33		53	.15		64	65.4
27	22	3.16		71 7	.17		9 9	3.16		35	.15		56	3.16		72 2	.15		63	64.5
28	41	3.16		17	.17		28	3.16		44	.17		9 15	3.33		11	.15		62	63.5
29	10 0	3.16		27	.17		47	3.33		54	.17		33	3.33		20	.17		61	62.6
30	19	3.16		37	0.17		10 5	3.33		72 4	0.17		51	3.33		30	0.17		60	61.6
31	38	3.16		47	.18		23	3.33		14	.18		10 9	3.33		40	.18		59	60.6
32	57	3.33		58	.18		41	3.33		25	.18		27	3.53		51	.18		58	59.7
33	11 15	3.33		72 9	.20		59	3.33		36	.18		44	3.33		73 2	.18		57	58.7
34	33	3.33		21	.20		11 17	3.33		47	.18		11 2	3.53		13	.18		56	57.7
35	51	3.33		33	0.20		35	3.33		58	0.20		19	3.53		24	0.20		55	56.7
36	12 9	3.33		45	.20		53	3.53		73 10	.20		36	3.53		36	.20		54	55.8
37	27	3.33		57	.22		12 10	3.53		22	.22		53	3.75		48	.20		53	54.8
38	45	3.53		73 10	.22		27	3.53		35	.22		12 9	3.53		74 0	.20		52	53.8
39	13 2	3.53		23	.23		44	3.53		48	.22		26	3.75		12	.22		51	52.8
40	19	3.53		37	0.23		13 1	3.75		74 1	0.22		42	3.75		25	0.22		50	51.8
41	36	3.53		51	.23		17	3.75		14	.23		58	3.75		38	.23		49	50.8
42	53	3.75		74 5	.23		33	3.75		28	.23		13 14	4.00		52	.23		48	49.9
43	14 9	3.75		19	.25		49	3.75		42	.25		29	4.00		75 6	.23		47	48.9
44	25	3.75		34	.25		14 5	4.00		57	.23		44	4.00		20	.23		46	47.9
45	41			49			20			75 11			59			34			45	46.9
t	a	60′/Δ	b	Δ/60′			a	60′/Δ	b	Δ/60′			a	60′/Δ	b	Δ/60′				a
	d = 69° 0′						d = 69° 30′						d = 70° 0′							

b / B	a = 69° 0′ h	d	60′/Δ	Z	t	Δ/60′	a = 69° 30′ h	d	60′/Δ	Z	t	Δ/60′	a = 70° 0′ h	d	60′/Δ	Z	t	Δ/60′	c / C	a / β
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
45	14 41		4.00	74 49		0.25	14 20		4.00	75 11		0.25	13 59		4.00	75 34		0.25	45	46.9
46	56		4.00	75 4		.27	35		4.00	26		.27	14 14		4.00	49		.25	44	45.9
47	15 11		4.00	20		.27	50		4.00	42		.25	29		4.29	76 4		.25	43	44.9
48	26		4.00	36		.27	15 5		4.29	57		.27	43		4.29	19		.25	42	43.9
49	41		4.00	52		.27	19		4.29	76 13		.27	57		4.29	34		.27	41	42.9
50	56		4.29	76 8		0.28	33		4.29	29		0.27	15 11		4.29	50		0.27	40	41.9
51	16 10		4.29	25		.28	47		4.29	45		.28	25		4.62	77 6		.27	39	40.8
52	24		4.29	42		.28	16 1		4.62	77 2		.28	38		4.62	22		.28	38	39.8
53	38		4.62	59		.30	14		4.62	19		.28	51		4.62	39		.27	37	38.8
54	51		4.62	77 17		.30	27		4.62	36		.30	16 4		5.00	55		.28	36	37.8
55	17 4		4.62	35		0.30	40		4.62	54		0.30	16		5.00	78 12		0.30	35	36.8
56	17		5.00	53		.30	53		5.00	78 12		.30	28		5.00	30		.28	34	35.8
57	29		5.00	78 11		.32	17 5		5.00	30		.30	40		5.00	47		.30	33	34.7
58	41		5.00	30		.32	17		5.45	48		.30	52		5.45	79 5		.30	32	33.7
59	53		5.00	49		.32	28		5.45	79 6		.32	17 3		5.45	23		.30	31	32.7
60	18 5		5.45	79 8		0.32	39		5.45	25		0.32	14		6.00	41		0.32	30	31.6
61	16		5.45	27		.33	50		5.45	44		.32	24		6.00	80 0		.30	29	30.6
62	27		6.00	47		.33	18 1		6.00	80 3		.32	34		6.00	18		.32	28	29.6
63	37		6.00	80 7		.33	11		6.00	22		.33	44		6.00	37		.32	27	28.5
64	47		6.00	27		.33	21		6.67	42		.32	54		6.67	56		.32	26	27.5
65	57		6.00	47		0.35	30		6.67	81 1		0.33	18 3		6.67	81 15		0.33	25	26.5
66	19 7		6.67	81 8		.33	39		6.67	21		.33	12		6.67	35		.32	24	25.4
67	16		6.67	28		.35	48		6.67	41		.33	21		7.50	54		.33	23	24.4
68	25		7.50	49		.35	57		7.50	82 1		.35	29		7.50	82 14		.33	22	23.3
69	33		7.50	82 10		.35	19 5		7.50	22		.35	37		7.50	34		.33	21	22.3
70	41		7.50	31		0.37	13		8.57	43		0.35	45		8.57	54		0.35	20	21.2
71	49		8.57	53		.35	20		8.57	83 4		.35	52		8.57	83 15		.33	19	20.2
72	56		8.57	83 14		.37	27		8.57	25		.35	59		8.57	35		.35	18	19.1
73	20 3		10.0	36		.37	34		10.0	46		.35	19 6		10.0	56		.33	17	18.1
74	9		10.0	58		.37	40		10.0	84 7		.35	12		10.0	84 16		.35	16	17.0
75	15		10.0	84 20		0.37	46		10.0	28		0.37	18		12.0	37		0.35	15	16.0
76	21		12.0	42		.37	52		12.0	50		.35	23		12.0	58		.35	14	14.9
77	26		12.0	85 4		.37	57		12.0	85 11		.37	28		12.0	85 19		.35	13	13.8
78	31		12.0	26		.38	20 2		15.0	33		.37	33		15.0	40		.37	12	12.8
79	36		15.0	49		.37	6		15.0	55		.37	37		15.0	86 2		.35	11	11.7
80	40		15.0	86 11		0.38	10		15.0	86 17		0.37	41		15.0	23		0.35	10	10.7
81	44		20.0	34		.38	14		20.0	39		.37	45		20.0	44		.37	9	9.6
82	47		20.0	57		.37	17		20.0	87 1		.37	48		20.0	87 6		.37	8	8.5
83	50		20.0	87 19		.38	20		20.0	23		.38	51		30.0	28		.35	7	7.5
84	53		30.0	42		.38	23		30.0	46		.37	53		30.0	49		.37	6	6.4
85	55		30.0	88 5		0.38	25		30.0	88 8		0.37	55		30.0	88 11		0.37	5	5.3
86	57		60.0	28		.38	27		60.0	30		.38	57		60.0	33		.37	4	4.3
87	58		60.0	51		.38	28		60.0	53		.37	58		60.0	55		.35	3	3.2
88	59		60.0	89 14		.38	29		60.0	89 15		.37	59		60.0	89 16		.37	2	2.1
89	21 0		—	37		.38	30		—	37		.38	20 0		—	38		.37	1	1.1
90	0			90 0			30			90 0			0			90 0			0	0.0
t	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′	a		60′/Δ	b		Δ/60′		a
	d = 69° 0′						d = 69° 30′						d = 70° 0′							

b / B	a = 70° 30′					a = 71° 0′					a = 71° 30′					c / C	a / β
	h \ d	60′/Δ		Z \ t	Δ/60′	h \ d	60′/Δ		Z \ t	Δ/60′	h \ d	60′/Δ		Z \ t	Δ/60′		
°	° ′			° ′		° ′			° ′		° ′			° ′		°	°
0	0 0	3.00		70 30	0.00	0 0	3.00		71 0	0.00	0 0	3.16		71 30	0.00	90	90.0
1	20	3.00		30	.02	20	3.16		0	.02	19	3.16		30	.02	89	89.1
2	40	3.00		31	.02	39	3.00		1	.02	38	3.16		31	.02	88	88.1
3	1 0	3.00		32	.02	59	3.16		2	.02	57	3.16		32	.02	87	87.2
4	20	3.00		33	.02	1 18	3.00		3	.02	1 16	3.16		33	.02	86	86.2
5	40	3.00		34	0.03	38	3.16		4	0.03	35	3.16		34	0.03	85	85.3
6	2 0	3.00		36	.03	57	3.00		6	.03	54	3.16		36	.03	84	84.3
7	20	3.00		38	.03	2 17	3.16		8	.03	2 13	3.16		38	.03	83	83.4
8	40	3.00		40	.05	36	3.16		10	.05	32	3.16		40	.05	82	82.4
9	3 0	3.00		43	.05	55	3.00		13	.05	51	3.16		43	.05	81	81.5
10	20	3.16		46	0.07	3 15	3.16		16	0.05	3 10	3.33		46	0.05	80	80.5
11	39	3.00		50	.07	34	3.16		19	.07	28	3.16		49	.07	79	79.6
12	59	3.16		54	.07	53	3.16		23	.07	47	3.16		53	.07	78	78.6
13	4 18	3.00		58	.07	4 12	3.16		27	.07	4 6	3.33		57	.07	77	77.7
14	38	3.16		71 2	.08	31	3.16		31	.08	24	3.16		72 1	.07	76	76.7
15	57	3.00		7	0.08	50	3.16		36	0.08	43	3.33		5	0.08	75	75.8
16	5 17	3.16		12	.08	5 9	3.16		41	.08	5 1	3.33		10	.08	74	74.8
17	36	3.16		17	.10	28	3.33		46	.10	19	3.16		15	.10	73	73.9
18	55	3.16		23	.10	46	3.16		52	.10	38	3.33		21	.10	72	72.9
19	6 14	3.16		29	.10	6 5	3.16		58	.10	56	3.33		27	.10	71	72.0
20	33	3.16		35	0.12	24	3.33		72 4	0.12	6 14	3.33		33	0.10	70	71.0
21	52	3.16		42	.12	42	3.33		11	.12	32	3.33		39	.12	69	70.1
22	7 11	3.16		49	.13	7 0	3.33		18	.12	50	3.53		46	.12	68	69.1
23	30	3.33		57	.13	18	3.33		25	.12	7 7	3.33		53	.12	67	68.1
24	48	3.16		72 5	.13	36	3.33		32	.13	25	3.53		73 0	.13	66	67.2
25	8 7	3.33		13	0.13	54	3.33		40	0.13	42	3.33		8	0.13	65	66.2
26	25	3.33		21	.13	8 12	3.33		48	.13	8 0	3.53		16	.13	64	65.2
27	43	3.33		29	.15	30	3.33		56	.15	17	3.53		24	.13	63	64.3
28	9 1	3.33		38	.15	48	3.53		73 5	.15	34	3.53		32	.15	62	63.3
29	19	3.33		47	.17	9 5	3.53		14	.17	51	3.53		41	.15	61	62.3
30	37	3.53		57	0.17	22	3.53		24	0.17	9 8	3.75		50	0.17	60	61.4
31	54	3.53		73 7	.17	39	3.53		34	.17	24	3.53		74 0	.17	59	60.4
32	10 11	3.53		17	.17	56	3.53		44	.17	41	3.75		10	.17	58	59.4
33	28	3.53		27	.18	10 13	3.53		54	.17	57	3.75		20	.17	57	58.4
34	45	3.53		38	.18	30	3.75		74 4	.18	10 13	3.75		30	.17	56	57.5
35	11 2	3.53		49	0.20	46	3.75		15	0.18	29	3.75		40	0.18	55	56.5
36	19	3.75		74 1	.20	11 2	3.75		26	.18	45	3.75		51	.18	54	55.5
37	35	3.75		13	.20	18	3.75		37	.20	11 1	4.00		75 2	.20	53	54.5
38	51	3.75		25	.20	34	3.75		49	.20	16	4.00		14	.20	52	53.5
39	12 7	3.75		37	.20	50	4.00		75 1	.20	31	4.00		26	.20	51	52.6
40	23	3.75		49	0.22	12 5	4.00		13	0.22	46	4.00		38	0.20	50	51.6
41	39	4.00		75 2	.22	20	4.00		26	.22	12 1	4.00		50	.20	49	50.6
42	54	4.00		15	.23	35	4.00		39	.22	16	4.29		76 2	.22	48	49.6
43	13 9	4.00		29	.23	50	4.29		52	.22	30	4.29		15	.22	47	48.6
44	24	4.00		43	.23	13 4	4.29		76 5	.23	44	4.29		28	.22	46	47.6
45	39			57		18			19		58			41		45	46.6
t	a	60′/Δ		b	Δ/60′	a	60′/Δ		b	Δ/60′	a	60′/Δ		b	Δ/60′		a
	d = 70° 30′					d = 71° 0′					d = 71° 30′						

	0.354				0.344				0.335					
b / B	a = 70° 30′				a = 71° 0′				a = 71° 30′				c / C	a / β
	h \ d	60′/Δ	Z \ t	Δ/60′	h \ d	60′/Δ	Z \ t	Δ/60′	h \ d	60′/Δ	Z \ t	Δ/60′		
°	° ′		° ′		° ′		° ′		° ′		° ′		°	°
45	13 39	4.00	75 57	0.23	13 18	4.29	76 19	0.23	12 58	4.29	76 41	0.23	45	46.6
46	54	4.29	76 11	.23	32	4.29	33	.23	13 12	4.62	55	.23	44	45.6
47	14 8	4.29	25	.25	46	4.29	47	.23	25	4.62	77 9	.23	43	44.6
48	22	4.29	40	.25	14 0	4.62	77 1	.25	38	4.62	23	.23	42	43.6
49	36	4.62	55	.25	13	4.62	16	.25	51	4.62	37	.25	41	42.6
50	49	4.62	77 10	0.27	26	4.62	31	0.25	14 4	4.62	52	0.25	40	41.6
51	15 2	4.62	26	.27	39	4.62	46	.27	17	5.00	78 7	.25	39	40.6
52	15	4.62	42	.27	52	5.00	78 2	.27	29	5.00	22	.25	38	39.6
53	28	5.00	58	.28	15 4	5.00	18	.27	41	5.00	37	.25	37	38.6
54	40	5.00	78 15	.27	16	5.00	34	.27	53	5.45	52	.27	36	37.5
55	52	5.00	31	0.28	28	5.00	50	0.27	15 4	5.45	79 8	0.27	35	36.5
56	16 4	5.00	48	.28	40	5.45	79 6	.28	15	5.45	24	.27	34	35.5
57	16	5.45	79 5	.28	51	5.45	23	.28	26	5.45	40	.28	33	34.5
58	27	5.45	22	.30	16 2	6.00	40	.28	37	6.00	57	.27	32	33.5
59	38	6.00	40	.30	12	6.00	57	.28	47	6.00	80 13	.28	31	32.4
60	48	6.00	58	0.30	22	6.00	80 14	0.28	57	6.00	30	0.28	30	31.4
61	58	6.00	80 16	.30	32	6.00	31	.30	16 7	6.67	47	.28	29	30.4
62	17 8	6.00	34	.30	42	6.00	49	.30	16	6.67	81 4	.30	28	29.4
63	18	6.67	52	.30	52	6.67	81 7	.30	25	6.67	22	.28	27	28.3
64	27	6.67	81 10	.32	17 1	6.67	25	.30	34	6.67	39	.30	26	27.3
65	36	6.67	29	0.32	10	7.50	43	0.32	43	7.50	57	0.30	25	26.3
66	45	6.67	48	.32	18	7.50	82 2	.30	51	7.50	82 15	.30	24	25.2
67	54	7.50	82 7	.33	26	7.50	20	.32	59	7.50	33	.30	23	24.2
68	18 2	7.50	27	.32	34	7.50	39	.32	17 7	8.57	51	.32	22	23.1
69	10	8.57	46	.33	42	8.57	58	.32	14	8.57	83 10	.30	21	22.1
70	17	8.57	83 6	0.32	49	8.57	83 17	0.32	21	8.57	28	0.32	20	21.1
71	24	8.57	25	.33	56	10.0	36	.33	28	10.0	47	.32	19	20.0
72	31	10.0	45	.33	18 2	10.0	56	.32	34	10.0	84 6	.32	18	19.0
73	37	10.0	84 5	.35	8	10.0	84 15	.33	40	10.0	25	.32	17	17.9
74	43	10.0	26	.33	14	10.0	35	.32	46	12.0	44	.32	16	16.9
75	49	12.0	46	0.33	20	12.0	54	0.33	51	12.0	85 3	0.32	15	15.8
76	54	12.0	85 6	.35	25	12.0	85 14	.33	56	12.0	22	.33	14	14.8
77	59	12.0	27	.33	30	15.0	34	.33	18 1	15.0	42	.32	13	13.7
78	19 4	15.0	47	.35	34	15.0	54	.33	5	15.0	86 1	.33	12	12.7
79	8	15.0	86 8	.35	38	15.0	86 14	.35	9	15.0	21	.32	11	11.6
80	12	20.0	29	0.35	42	20.0	35	0.33	13	20.0	40	0.33	10	10.6
81	15	20.0	50	.35	45	20.0	55	.33	16	20.0	87 0	.33	9	9.5
82	18	20.0	87 11	.35	48	20.0	87 15	.35	19	20.0	20	.33	8	8.5
83	21	30.0	32	.35	51	30.0	36	.33	22	30.0	40	.33	7	7.4
84	23	30.0	53	.35	53	30.0	56	.35	24	30.0	88 0	.33	6	6.3
85	25	30.0	88 14	0.35	55	30.0	88 17	0.33	26	60.0	20	0.33	5	5.3
86	27	60.0	35	.35	57	60.0	37	.35	27	60.0	40	.33	4	4.2
87	28	60.0	56	.37	58	60.0	58	.35	28	60.0	89 0	.33	3	3.2
88	29	60.0	89 18	.35	59	60.0	89 19	.33	29	60.0	20	.33	2	2.1
89	30	—	39	.35	19 0	—	39	.35	30	—	40	.33	1	1.1
90	30		90 0		0		90 0		30		90 0		0	0.0
t	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′		a
	d = 70° 30′				d = 71° 0′				d = 71° 30′					

b / B	a = 72° 0′						a = 72° 30′						a = 73° 0′						c / C	α / β
	h \ d	60′/Δ		Z \ t		Δ/60′	h \ d	60′/Δ		Z \ t		Δ/60′	h \ d	60′/Δ		Z \ t		Δ/60′		
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
0	0 0	3.16		72 0		0.00	0 0	3.33		72 30		0.00	0 0	3.33		73 0		0.00	90	90.0
1	19	3.33		0		.02	18	3.33		30		.02	18	3.53		0		.02	89	89.0
2	37	3.16		1		.00	36	3.33		31		.00	35	3.33		1		.00	88	88.1
3	56	3.33		1		.02	54	3.33		31		.02	53	3.53		1		.02	87	87.1
4	1 14	3.16		2		.03	1 12	3.33		32		.03	1 10	3.33		2		.03	86	86.2
5	33	3.33		4		0.03	30	3.33		34		0.02	28	3.53		4		0.02	85	85.2
6	51	3.33		6		.03	48	3.33		35		.03	45	3.33		5		.03	84	84.3
7	2 9	3.16		8		.03	2 6	3.33		37		.03	2 3	3.53		7		.03	83	83.3
8	28	3.33		10		.05	24	3.33		39		.05	20	3.53		9		.05	82	82.4
9	46	3.16		13		.05	42	3.33		42		.05	37	3.33		12		.05	81	81.4
10	3 5	3.33		16		0.05	3 0	3.53		45		0.05	55	3.53		15		0.05	80	80.5
11	23	3.33		19		.05	17	3.33		48		.05	3 12	3.53		18		.05	79	79.5
12	41	3.33		22		.07	35	3.33		51		.07	29	3.53		21		.07	78	78.5
13	59	3.33		26		.07	53	3.53		55		.07	46	3.53		25		.07	77	77.6
14	4 17	3.33		30		.07	4 10	3.33		59		.07	4 3	3.53		29		.07	76	76.6
15	35	3.33		34		0.08	28	3.53	73	3		0.08	20	3.53		33		0.07	75	75.7
16	53	3.33		39		.08	45	3.33		8		.08	37	3.53		37		.08	74	74.7
17	5 11	3.33		44		.08	5 3	3.53		13		.08	54	3.53		42		.08	73	73.7
18	29	3.53		49		.10	20	3.53		18		.10	5 11	3.53		47		.08	72	72.8
19	46	3.33		55		.10	37	3.53		24		.10	28	3.75		52		.10	71	71.8
20	6 4	3.53	73	1		0.10	54	3.53		30		0.10	44	3.53		58		0.10	70	70.9
21	21	3.33		7		.12	6 11	3.53		36		.10	6 1	3.75	74	4		.10	69	69.9
22	39	3.53		14		.12	28	3.53		42		.12	17	3.53		10		.12	68	68.9
23	56	3.53		21		.12	45	3.53		49		.12	34	3.75		17		.12	67	68.0
24	7 13	3.53		28		.12	7 2	3.75		56		.12	50	3.75		24		.12	66	67.0
25	30	3.53		35		0.13	18	3.53	74	3		0.13	7 6	3.75		31		0.12	65	66.0
26	47	3.53		43		.13	35	3.75		11		.13	22	3.75		38		.13	64	65.1
27	8 4	3.53		51		.13	51	3.75		19		.13	38	3.75		46		.13	63	64.1
28	21	3.75		59		.15	8 7	3.75		27		.13	54	4.00		54		.13	62	63.1
29	37	3.75	74	8		.15	23	3.75		35		.15	8 9	3.75	75	2		.13	61	62.1
30	53	3.75		17		0.15	39	3.75		44		0.15	25	4.00		10		0.15	60	61.2
31	9 9	3.75		26		.17	55	4.00		53		.15	40	4.00		19		.15	59	60.2
32	25	3.75		36		.17	9 10	3.75	75	2		.15	55	4.00		28		.15	58	59.2
33	41	3.75		46		.17	26	4.00		11		.17	9 10	4.00		37		.15	57	58.2
34	57	3.75		56		.17	41	4.00		21		.17	25	4.29		46		.17	56	57.2
35	10 13	4.00	75	6		0.17	56	4.00		31		0.17	39	4.00		56		0.17	55	56.3
36	28	4.00		16		.18	10 11	4.00		41		.18	54	4.29	76	6		.18	54	55.3
37	43	4.00		27		.18	26	4.29		52		.18	10 8	4.29		17		.17	53	54.3
38	58	4.00		38		.20	40	4.29	76	3		.18	22	4.29		27		.18	52	53.3
39	11 13	4.00		50		.18	54	4.29		14		.18	36	4.29		38		.18	51	52.3
40	28	4.29	76	1		0.20	11 8	4.29		25		0.20	50	4.29		49		0.18	50	51.3
41	42	4.29		13		.22	22	4.29		37		.20	11 4	4.62	77	0		.20	49	50.3
42	56	4.29		26		.20	36	4.29		49		.20	17	4.62		12		.20	48	49.3
43	12 10	4.29		38		.22	50	4.62	77	1		.20	30	4.62		24		.20	47	48.4
44	24	4.29		51		.22	12 3	4.62		13		.22	43	4.62		36		.20	46	47.4
45	38		77	4			16			26			56			48			45	46.4
t	a	60′/Δ		b		Δ/60′	a	60′/Δ		b		Δ/60′	a	60′/Δ		b		Δ/60′		a
	d = 72° 0′						d = 72° 30′						d = 73° 0′							

0.325 0.315 0.306

b / B	a = 72° 0′						a = 72° 30′						a = 73° 0′						c / C	α / β
	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′		
°	°	′		°	′		°	′		°	′		°	′		°	′		°	°
45	12	38	4.62	77	4	0.22	12	16	4.62	77	26	0.22	11	56	4.62	77	48	0.22	45	46.4
46		51	4.62		17	.22		29	4.62		39	.22	12	9	5.00	78	1	.20	44	45.4
47	13	4	4.62		30	.23		42	4.62		52	.22		21	5.00		13	.22	43	44.4
48		17	5.00		44	.23		55	5.00	78	5	.23		33	5.00		26	.22	42	43.4
49		29	5.00		58	.23	13	7	5.00		19	.23		45	5.00		39	.23	41	42.3
50		41	5.00	78	12	0.23		19	5.00		33	0.23		57	5.45		53	0.23	40	41.3
51		53	5.00		26	.25		31	5.00		47	.23	13	8	5.45	79	7	.23	39	40.3
52	14	5	5.00		41	.25		43	5.45	79	1	.23		19	5.45		21	.23	38	39.3
53		17	5.00		56	.25		54	5.45		15	.25		30	5.45		35	.23	37	38.3
54		29	5.45	79	11	.25	14	5	5.45		30	.25		41	5.45		49	.23	36	37.3
55		40	5.45		26	0.27		16	6.00		45	0.25		52	6.00	80	3	0.25	35	36.3
56		51	6.00		42	.27		26	6.00	80	0	.25	14	2	6.00		18	.25	34	35.3
57	15	1	6.00		58	.27		36	6.00		15	.27		12	6.00		33	.25	33	34.3
58		11	6.00	80	14	.27		46	6.00		31	.27		22	6.67		48	.25	32	33.2
59		21	6.00		30	.27		56	6.00		47	.27		31	6.67	81	3	.25	31	32.2
60		31	6.00		46	0.28	15	6	6.67	81	3	0.27		40	6.67		18	0.27	30	31.2
61		41	6.67	81	3	.28		15	6.67		19	.27		49	6.67		34	.27	29	30.2
62		50	6.67		20	.28		24	6.67		35	.27		58	7.50		50	.27	28	29.1
63		59	6.67		37	.28		33	7.50		51	.28	15	6	7.50	82	6	.27	27	28.1
64	16	8	7.50		54	.28		41	7.50	82	8	.28		14	7.50		22	.27	26	27.1
65		16	7.50	82	11	0.28		49	7.50		25	0.28		22	7.50		38	0.28	25	26.1
66		24	7.50		28	.30		57	8.57		42	.28		30	8.57		55	.27	24	25.0
67		32	8.57		46	.30	16	4	8.57		59	.28		37	8.57	83	11	.28	23	24.0
68		39	8.57	83	4	.30		11	8.57	83	16	.28		44	8.57		28	.28	22	23.0
69		46	8.57		22	.30		18	8.57		33	.30		51	10.0		45	.28	21	21.9
70		53	10.0		40	0.30		25	10.0		51	0.28		57	10.0	84	2	0.28	20	20.9
71		59	10.0		58	.30		31	10.0	84	8	.30	16	3	10.0		19	.28	19	19.9
72	17	5	10.0	84	16	.30		37	10.0		26	.30		9	12.0		36	.28	18	18.8
73		11	10.0		34	.32		43	12.0		44	.30		14	12.0		53	.30	17	17.8
74		17	12.0		53	.32		48	12.0	85	2	.30		19	12.0	85	11	.28	16	16.7
75		22	12.0	85	12	0.30		53	12.0		20	0.30		24	12.0		28	0.30	15	15.7
76		27	15.0		30	.32		58	15.0		38	.30		29	15.0		46	.30	14	14.7
77		31	15.0		49	.32	17	2	15.0		56	.32		33	15.0	86	4	.30	13	13.6
78		35	15.0	86	8	.32		6	15.0	86	15	.30		37	15.0		22	.30	12	12.6
79		39	15.0		27	.32		10	15.0		33	.32		41	20.0		40	.30	11	11.5
80		43	20.0		46	0.32		14	20.0		52	0.30		44	20.0		58	0.30	10	10.5
81		46	20.0	87	5	.33		17	20.0	87	10	.32		47	20.0	87	16	.30	9	9.4
82		49	20.0		25	.32		20	30.0		29	.32		50	30.0		34	.30	8	8.4
83		52	30.0		44	.32		22	30.0		48	.32		52	30.0		52	.30	7	7.3
84		54	30.0	88	3	.33		24	30.0	88	7	.30		54	30.0	88	10	.30	6	6.3
85		56	60.0		23	0.32		26	60.0		25	0.32		56	60.0		28	0.32	5	5.2
86		57	60.0		42	.32		27	60.0		44	.32		57	60.0		47	.30	4	4.2
87		58	60.0	89	1	.33		28	60.0	89	3	.32		58	60.0	89	5	.30	3	3.1
88		59	60.0		21	.32		29	60.0		22	.32		59	60.0		23	.32	2	2.1
89	18	0	—		40	.33		30	—		41	.32	17	0	—		42	.30	1	1.0
90		0		90	0			30		90	0			0		90	0		0	0.0
t	a	60′/Δ	b	Δ/60′			a	60′/Δ	b	Δ/60′			a	60′/Δ	b	Δ/60′				α
	d = 72° 0′						d = 72° 30′						d = 73° 0′							

b / B	a = 73° 30′					a = 74° 0′					a = 74° 30′					c / C	a / β
	h \ d	60′/Δ		Z \ t	Δ/60′	h \ d	60′/Δ		Z \ t	Δ/60′	h \ d	60′/Δ		Z \ t	Δ/60′		
	° ′			° ′		° ′			° ′		° ′			° ′			
0	0 0	3.53		73 30	0.00	0 0	3.53		74 0	0.00	0 0	3.75		74 30	0.00	90	90.0
1	17	3.53		30	.02	17	3.75		0	.02	16	3.75		30	.02	89	89.0
2	34	3.53		31	.00	33	3.53		1	.00	32	3.75		31	.00	88	88.1
3	51	3.53		31	.02	50	3.75		1	.02	48	3.75		31	.02	87	87.1
4	1 8	3.53		32	.02	1 6	3.53		2	.02	1 4	3.75		32	.02	86	86.2
5	25	3.53		33	0.03	23	3.75		3	0.03	20	3.75		33	0.03	85	85.2
6	42	3.53		35	.03	39	3.53		5	.03	36	3.75		35	.03	84	84.2
7	59	3.53		37	.03	56	3.75		7	.03	52	3.75		37	.03	83	83.3
8	2 16	3.53		39	.03	2 12	3.75		9	.03	2 8	3.75		39	.03	82	82.3
9	33	3.53		41	.05	28	3.53		11	.05	24	3.75		41	.03	81	81.3
10	50	3.75		44	0.05	45	3.75		14	0.05	40	4.00		43	0.05	80	80.4
11	3 6	3.53		47	.05	3 1	3.75		17	.05	55	3.75		46	.05	79	79.4
12	23	3.53		50	.07	17	3.75		20	.05	3 11	3.75		49	.07	78	78.5
13	40	3.75		54	.07	33	3.75		23	.07	27	4.00		53	.05	77	77.5
14	56	3.53		58	.07	49	3.75		27	.07	42	3.75		56	.07	76	76.5
15	4 13	3.75		74 2	0.07	4 5	3.75		31	0.07	58	3.75		75 0	0.07	75	75.6
16	29	3.53		6	.08	21	3.75		35	.08	4 14	4.00		4	.08	74	74.6
17	46	3.75		11	.08	37	3.75		40	.08	29	4.00		9	.07	73	73.6
18	5 2	3.75		16	.08	53	3.75		45	.08	44	4.00		13	.08	72	72.7
19	18	3.75		21	.10	5 9	3.75		50	.08	59	4.00		18	.08	71	71.7
20	34	3.75		27	0.10	25	4.00		55	0.10	5 14	4.00		23	0.10	70	70.7
21	50	3.75		33	.10	40	3.75		75 1	.10	29	4.00		29	.10	69	69.7
22	6 6	3.75		39	.10	56	4.00		7	.10	44	4.00		35	.10	68	68.8
23	22	3.75		45	.10	6 11	4.00		13	.10	59	4.00		41	.10	67	67.8
24	38	3.75		51	.12	26	4.00		19	.12	6 14	4.00		47	.10	66	66.8
25	54	4.00		58	0.12	41	4.00		26	0.12	29	4.00		53	0.12	65	65.9
26	7 9	3.75		75 5	.13	56	4.00		33	.12	44	4.29		76 0	.12	64	64.9
27	25	4.00		13	.13	7 11	4.00		40	.13	58	4.29		7	.12	63	63.9
28	40	4.00		21	.13	26	4.00		48	.12	7 12	4.29		14	.13	62	62.9
29	55	4.00		29	.13	41	4.29		55	.13	26	4.29		22	.13	61	62.0
30	8 10	4.00		37	0.13	55	4.00		76 3	0.13	40	4.29		30	0.13	60	61.0
31	25	4.00		45	.15	8 10	4.29		11	.15	54	4.29		38	.13	59	60.0
32	40	4.29		54	.15	24	4.29		20	.15	8 8	4.29		46	.13	58	59.0
33	54	4.29		76 3	.15	38	4.29		29	.15	22	4.29		54	.15	57	58.0
34	9 8	4.29		12	.17	52	4.29		38	.15	36	4.62		77 3	.15	56	57.0
35	22	4.29		22	0.17	9 6	4.62		47	0.15	49	4.62		12	0.15	55	56.1
36	36	4.29		32	.17	19	4.29		56	.17	9 2	4.62		21	.17	54	55.1
37	50	4.29		42	.17	33	4.62		77 6	.17	15	4.62		31	.15	53	54.1
38	10 4	4.29		52	.17	46	4.62		16	.17	28	4.62		40	.17	52	53.1
39	18	4.62		77 2	.18	59	4.62		26	.18	41	4.62		50	.17	51	52.1
40	31	4.62		13	0.18	10 12	4.62		37	0.17	54	5.00		78 0	0.18	50	51.1
41	44	4.62		24	.18	25	4.62		47	.18	10 6	5.00		11	.17	49	50.1
42	57	4.62		35	.18	38	5.00		58	.18	18	5.00		21	.18	48	49.1
43	11 10	4.62		46	.20	50	5.00		78 9	.20	30	5.00		32	.18	47	48.1
44	23	5.00		58	.20	11 2	5.00		21	.18	42	5.00		43	.18	46	47.1
45	35			78 10		14			32		54			54		45	46.1
t	a	60′/Δ		b	Δ/60′	a	60′/Δ		b	Δ/60′	a	60′/Δ		b	Δ/60′		a
	d = 73° 30′					d = 74° 0′					d = 74° 30′						

b / B	a = 73° 30′ h	d	60′/Δ	Z	t	Δ/60′	a = 74° 0′ h	d	60′/Δ	Z	t	Δ/60′	a = 74° 30′ h	d	60′/Δ	Z	t	Δ/60′	c / C	a / β
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
45	11 35		5.00	78 10		0.20	11 14		5.00	78 32		0.20	10 54		5.45	78 54		0.20	45	46.1
46	47		5.00	22		.20	26		5.00	44		.20	11 5		5.45	79 6		.18	44	45.1
47	59		5.00	34		.22	38		5.45	56		.20	16		5.45	17		.20	43	44.1
48	12 11		5.00	47		.22	49		5.45	79 8		.22	27		5.45	29		.20	42	43.1
49	23		5.45	79 0		.22	12 0		5.45	21		.20	38		5.45	41		.20	41	42.1
50	34		5.45	13		0.22	11		5.45	33		0.22	49		6.00	53		0.22	40	41.1
51	45		5.45	26		.23	22		5.45	46		.22	59		6.00	80 6		.22	39	40.1
52	56		5.45	40		.23	33		6.00	59		.23	12 9		6.00	19		.22	38	39.1
53	13 7		6.00	54		.22	43		6.00	80 13		.22	19		6.00	32		.22	37	38.1
54	17		6.00	80 7		.23	53		6.00	26		.23	29		6.00	45		.22	36	37.1
55	27		6.00	21		0.25	13 3		6.00	40		0.23	39		6.67	58		0.22	35	36.1
56	37		6.00	36		.23	13		6.67	54		.23	48		6.67	81 11		.23	34	35.1
57	47		6.67	50		.25	22		6.67	81 8		.23	57		6.67	25		.22	33	34.0
58	56		6.67	81 5		.25	31		6.67	22		.23	13 6		6.67	38		.23	32	33.0
59	14 5		6.67	20		.25	40		6.67	36		.23	15		7.50	52		.23	31	32.0
60	14		6.67	35		0.25	49		7.50	50		0.25	23		7.50	82 6		0.23	30	31.0
61	23		7.50	50		.25	57		7.50	82 5		.25	31		7.50	20		.25	29	30.0
62	31		7.50	82 5		.25	14 5		7.50	20		.25	39		7.50	35		.23	28	29.0
63	39		7.50	20		.27	13		7.50	35		.25	47		8.57	49		.25	27	27.9
64	47		7.50	36		.27	21		8.57	50		.25	54		8.57	83 4		.25	26	26.9
65	55		8.57	52		0.27	28		8.57	83 5		0.27	14 1		8.57	19		0.25	25	25.9
66	15 2		8.57	83 8		.27	35		8.57	21		.25	8		8.57	34		.25	24	24.9
67	9		8.57	24		.27	42		8.57	36		.27	15		10.0	49		.25	23	23.8
68	16		8.57	40		.27	49		10.0	52		.27	21		10.0	84 4		.25	22	22.8
69	23		10.0	56		.28	55		10.0	84 8		.27	27		10.0	19		.27	21	21.8
70	29		10.0	84 13		0.27	15 1		10.0	24		0.27	33		12.0	35		0.25	20	20.7
71	35		12.0	29		.28	7		12.0	40		.27	38		12.0	50		.27	19	19.7
72	40		12.0	46		.28	12		12.0	56		.27	43		12.0	85 6		.27	18	18.7
73	45		12.0	85 3		.28	17		12.0	85 12		.28	48		12.0	22		.27	17	17.6
74	50		12.0	20		.28	22		12.0	29		.27	53		12.0	38		.27	16	16.6
75	55		12.0	37		0.28	27		15.0	45		0.28	58		15.0	54		0.27	15	15.6
76	16 0		15.0	54		.28	31		15.0	86 2		.28	15 2		15.0	86 10		.27	14	14.5
77	4		15.0	86 11		.28	35		15.0	19		.27	6		20.0	26		.27	13	13.5
78	8		20.0	28		.30	39		20.0	35		.28	9		20.0	42		.27	12	12.5
79	11		20.0	46		.28	42		20.0	52		.28	12		20.0	58		.27	11	11.4
80	14		20.0	87 3		0.30	45		20.0	87 9		0.28	15		20.0	87 14		0.28	10	10.4
81	17		20.0	21		.28	48		20.0	26		.28	18		20.0	31		.27	9	9.4
82	20		30.0	38		.30	51		30.0	43		.28	21		30.0	47		.28	8	8.3
83	22		30.0	56		.28	53		30.0	88 0		.28	23		30.0	88 4		.27	7	7.3
84	24		30.0	88 13		.30	55		60.0	17		.28	25		30.0	20		.28	6	6.2
85	26		60.0	31		0.30	56		60.0	34		0.28	27		60.0	37		0.27	5	5.2
86	27		60.0	49		.30	57		60.0	51		.28	28		60.0	53		.28	4	4.2
87	28		60.0	89 7		.28	58		60.0	89 8		.30	29		60.0	89 10		.28	3	3.1
88	29		60.0	24		.30	59		60.0	26		.28	30		—	27		.27	2	2.1
89	30		—	42		.30	16 0		—	43		.28	30		—	43		.28	1	1.0
90	30			90 0			0			90 0			30			90 0			0	0.0
t	a	60′/Δ	b	Δ/60′			a	60′/Δ	b	Δ/60′			a	60′/Δ	b	Δ/60′				a
	d = 73° 30′						d = 74° 0′						d = 74° 30′							

b / B	a = 75° 0′						a = 75° 30′						a = 76° 0′						c	a
	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	C	β
°	°	′		°	′		°	′		°	′		°	′		°	′		°	°
0	0	0	3.75	75	0	0.00	0	0	4.00	75	30	0.00	0	0	4.00	76	0	0.00	90	90.0
1		16	4.00		0	.02		15	4.00		30	.02		15	4.29		0	.00	89	89.0
2		31	3.75		1	.00		30	4.00		31	.00		29	4.00		0	.02	88	88.1
3		47	4.00		1	.02		45	4.00		31	.02		44	4.29		1	.02	87	87.1
4	1	2	3.75		2	.02	1	0	4.00		32	.02		58	4.00		2	.02	86	86.1
5		18	4.00		3	0.03		15	4.00		33	0.02	1	13	4.29		3	0.02	85	85.2
6		33	3.75		5	.02		30	4.00		34	.03		27	4.29		4	.03	84	84.2
7		49	4.00		6	.03		45	4.00		36	.03		41	4.00		6	.03	83	83.2
8	2	4	4.00		8	.03	2	0	4.00		38	.03		56	4.29		8	.03	82	82.3
9		19	3.75		10	.05		15	4.00		40	.05	2	10	4.00		10	.03	81	81.3
10		35	4.00		13	0.05		30	4.29		43	0.03		25	4.29		12	0.05	80	80.3
11		50	4.00		16	.05		44	4.00		45	.05		39	4.29		15	.05	79	79.3
12	3	5	4.00		19	.05		59	4.00		48	.05		53	4.29		18	.05	78	78.4
13		20	4.00		22	.05	3	14	4.29		51	.07	3	7	4.29		21	.05	77	77.4
14		35	4.00		25	.07		28	4.00		55	.05		21	4.29		24	.05	76	76.4
15		50	4.00		29	0.07		43	4.29		58	0.07		35	4.29		27	0.07	75	75.5
16	4	5	4.00		33	.08		57	4.00	76	2	.08		49	4.29		31	.07	74	74.5
17		20	4.00		38	.07	4	12	4.29		7	.07	4	3	4.29		35	.08	73	73.5
18		35	4.00		42	.08		26	4.00		11	.08		17	4.29		40	.07	72	72.5
19		50	4.00		47	.08		41	4.29		16	.07		31	4.29		44	.08	71	71.6
20	5	5	4.29		52	0.08		55	4.29		20	0.08		45	4.29		49	0.08	70	70.6
21		19	4.00		57	.10	5	9	4.29		25	.10		59	4.62		54	.08	69	69.6
22		34	4.29	76	3	.10		23	4.29		31	.10	5	12	4.29		59	.08	68	68.6
23		48	4.00		9	.10		37	4.29		37	.10		26	4.62	77	4	.10	67	67.7
24	6	3	4.29		15	.10		51	4.62		43	.10		39	4.62		10	.10	66	66.7
25		17	4.29		21	0.10	6	4	4.29		49	0.10		52	4.62		16	0.10	65	65.7
26		31	4.29		27	.12		18	4.29		55	.10	6	5	4.62		22	.10	64	64.7
27		45	4.29		34	.12		32	4.62	77	1	.12		18	4.62		28	.12	63	63.7
28		59	4.29		41	.12		45	4.62		8	.12		31	4.62		35	.12	62	62.8
29	7	13	4.62		48	.13		58	4.62		15	.12		44	4.62		42	.12	61	61.8
30		26	4.29		56	0.13	7	11	4.62		22	0.13		57	4.62		49	0.12	60	60.8
31		40	4.62	77	4	.13		24	4.62		30	.13	7	10	5.00		56	.13	59	59.8
32		53	4.62		12	.13		37	4.62		38	.13		22	5.00	78	4	.12	58	58.8
33	8	6	4.62		20	.13		50	4.62		46	.13		34	5.00		11	.13	57	57.8
34		19	4.62		28	.15	8	3	4.62		54	.13		46	5.00		19	.13	56	56.9
35		32	4.62		37	0.15		16	5.00	78	2	0.15		58	5.00		27	0.15	55	55.9
36		45	4.62		46	.15		28	5.00		11	.15	8	10	5.00		36	.13	54	54.9
37		58	5.00		55	.15		40	5.00		20	.15		22	5.00		44	.15	53	53.9
38	9	10	5.00	78	4	.17		52	5.00		29	.15		34	5.00		53	.15	52	52.9
39		22	5.00		14	.17	9	4	5.00		38	.15		46	5.45	79	2	.15	51	51.9
40		34	5.00		24	0.17		16	5.45		47	0.17		57	5.45		11	0.17	50	50.9
41		46	5.00		34	.17		27	5.00		57	.17	9	8	5.45		21	.15	49	49.9
42		58	5.00		44	.18		39	5.45	79	7	.17		19	5.45		30	.17	48	48.9
43	10	10	5.00		55	.17		50	5.45		17	.18		30	5.45		40	.17	47	47.9
44		22	5.45	79	5	.18	10	1	5.45		28	.17		41	6.00		50	.17	46	46.9
45		33			16			12			38			51		80	0		45	45.9
t	a	60′/Δ	b	Δ/60′			a	60′/Δ	b	Δ/60′			a	60′/Δ	b	Δ/60′				a
	d = 75° 0′						d = 75° 30′						d = 76° 0′							

b / B	a = 75° 0′ h / d	60′/Δ	Z / t	Δ/60′	a = 75° 30′ h / d	60′/Δ	Z / t	Δ/60′	a = 76° 0′ h / d	60′/Δ	Z / t	Δ/60′	c / C	a / β
°	° ′		° ′		° ′		° ′		° ′		° ′		°	°
45	10 33	5.45	79 16	0.18	10 12	5.45	79 38	0.18	9 51	6.00	80 0	0.17	45	45.9
46	44	5.45	27	.20	23	6.00	49	.18	10 1	6.00	10	.18	44	44.9
47	55	5.45	39	.18	33	6.00	80 0	.18	11	6.00	21	.18	43	43.9
48	11 6	6.00	50	.20	43	6.00	11	.18	21	6.00	32	.18	42	42.9
49	16	6.00	80 2	.20	53	6.00	22	.20	31	6.00	43	.18	41	41.9
50	26	6.00	14	0.20	11 3	6.00	34	0.18	41	6.67	54	0.18	40	40.9
51	36	6.00	26	.20	13	6.00	45	.20	50	6.67	81 5	.18	39	39.9
52	46	6.00	38	.20	23	6.67	57	.20	59	6.67	16	.20	38	38.9
53	56	6.67	50	.22	32	6.67	81 9	.20	11 8	6.67	28	.20	37	37.9
54	12 5	6.67	81 3	.22	41	6.67	21	.22	17	6.67	40	.20	36	36.9
55	14	6.67	16	0.22	50	6.67	34	0.20	26	7.50	52	0.20	35	35.9
56	23	6.67	29	.22	59	7.50	46	.22	34	7.50	82 4	.20	34	34.9
57	32	6.67	42	.22	12 7	7.50	59	.22	42	7.50	16	.20	33	33.9
58	41	7.50	55	.23	15	7.50	82 12	.22	50	7.50	28	.22	32	32.8
59	49	7.50	82 9	.22	23	7.50	25	.22	58	7.50	41	.22	31	31.8
60	57	7.50	22	0.23	31	7.50	38	0.22	12 6	8.57	54	0.22	30	30.8
61	13 5	7.50	36	.23	39	8.57	51	.23	13	8.57	83 7	.22	29	29.8
62	13	8.57	50	.23	46	8.57	83 5	.22	20	8.57	20	.22	28	28.8
63	20	8.57	83 4	.23	53	8.57	18	.23	27	8.57	33	.22	27	27.8
64	27	8.57	18	.23	13 0	8.57	32	.23	34	10.0	46	.22	26	26.7
65	34	8.57	32	0.25	7	10.0	46	0.23	40	10.0	59	0.22	25	25.7
66	41	10.0	47	.23	13	10.0	84 0	.23	46	10.0	84 12	.23	24	24.7
67	47	10.0	84 1	.25	19	10.0	14	.23	52	10.0	26	.23	23	23.7
68	53	10.0	16	.25	25	10.0	28	.23	58	12.0	40	.23	22	22.7
69	59	10.0	31	.25	31	12.0	42	.25	13 3	12.0	54	.23	21	21.6
70	14 5	12.0	46	0.25	36	12.0	57	0.23	8	12.0	85 8	0.23	20	20.6
71	10	12.0	85 1	.25	41	12.0	85 11	.25	13	12.0	22	.23	19	19.6
72	15	12.0	16	.25	46	12.0	26	.23	18	12.0	36	.23	18	18.6
73	20	12.0	31	.27	51	12.0	40	.25	23	15.0	50	.23	17	17.5
74	25	15.0	47	.25	56	15.0	55	.25	27	15.0	86 4	.23	16	16.5
75	29	15.0	86 2	0.25	14 0	15.0	86 10	0.25	31	15.0	18	0.25	15	15.5
76	33	15.0	17	.27	4	20.0	25	.25	35	20.0	33	.23	14	14.4
77	37	20.0	33	.27	7	20.0	40	.25	38	20.0	47	.25	13	13.4
78	40	20.0	49	.25	10	20.0	55	.25	41	20.0	87 2	.25	12	12.4
79	43	20.0	87 4	.27	13	20.0	87 10	.27	44	20.0	17	.23	11	11.4
80	46	20.0	20	0.27	16	20.0	26	0.25	47	20.0	31	0.25	10	10.3
81	49	30.0	36	.27	19	30.0	41	.25	50	30.0	46	.25	9	9.3
82	51	30.0	52	.27	21	30.0	56	.27	52	30.0	88 1	.23	8	8.3
83	53	30.0	88 8	.27	23	30.0	88 12	.25	54	30.0	15	.25	7	7.2
84	55	30.0	24	.27	25	30.0	27	.25	56	60.0	30	.25	6	6.2
85	57	60.0	40	0.27	27	60.0	42	0.27	57	60.0	45	0.25	5	5.2
86	58	60.0	56	.27	28	60.0	58	.25	58	60.0	89 0	.25	4	4.1
87	59	60.0	89 12	.27	29	60.0	89 13	.27	59	60.0	15	.25	3	3.1
88	15 0	—	28	.27	30	—	29	.25	14 0	—	30	.25	2	2.1
89	0	—	44	.27	30	—	44	.27	0	—	45	.25	1	1.0
90	0		90 0		30		90 0		0		90 0		0	0.0

t	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′		a
	d = 75° 0′				d = 75° 30′				d = 76° 0′					

b / B	a = 76° 30′					a = 77° 0′					a = 77° 30′					c / C	a / β
	h \ d	60′/Δ		Z \ t	Δ/60′	h \ d	60′/Δ		Z \ t	Δ/60′	h \ d	60′/Δ		Z \ t	Δ/60′		
°	° ′			° ′		° ′			° ′		° ′			° ′		°	°
0	0 0	4.29		76 30	0.00	0 0	4.29		77 0	0.00	0 0	4.62		77 30	0.00	90	90.0
1	14	4.29		30	.00	14	4.62		0	.00	13	4.62		30	.00	89	89.0
2	28	4.29		30	.02	27	4.29		0	.02	26	4.62		30	.02	88	88.1
3	42	4.29		31	.02	41	4.62		1	.02	39	4.62		31	.02	87	87.1
4	56	4.29		32	.02	54	4.62		2	.02	52	4.62		32	.02	86	86.1
5	1 10	4.29		33	0.02	1 7	4.29		3	0.02	1 5	4.62		33	0.02	85	85.1
6	24	4.29		34	.03	21	4.62		4	.03	18	4.62		34	.02	84	84.2
7	38	4.29		36	.03	34	4.29		6	.02	31	4.62		35	.03	83	83.2
8	52	4.29		38	.03	48	4.62		7	.03	44	5.00		37	.03	82	82.2
9	2 6	4.62		40	.03	2 1	4.62		9	.03	56	4.62		39	.03	81	81.2
10	19	4.29		42	0.03	14	4.29		11	0.05	2 9	4.62		41	0.03	80	80.3
11	33	4.29		44	.05	28	4.62		14	.03	22	4.62		43	.05	79	79.3
12	47	4.29		47	.05	41	4.62		16	.05	35	5.00		46	.05	78	78.3
13	3 1	4.62		50	.05	54	4.62		19	.05	47	4.62		49	.05	77	77.3
14	14	4.29		53	.07	3 7	4.62		22	.07	3 0	4.62		52	.05	76	76.3
15	28	4.29		57	0.05	20	4.62		26	0.05	13	5.00		55	0.05	75	75.4
16	42	4.62	77	0	.07	33	4.62		29	.07	25	4.62		58	.07	74	74.4
17	55	4.62		4	.07	46	4.62		33	.07	38	5.00	78	2	.07	73	73.4
18	4 8	4.29		8	.08	59	4.62		37	.07	50	5.00		6	.07	72	72.4
19	22	4.62		13	.07	4 12	4.62		41	.07	4 2	4.62		10	.07	71	71.5
20	35	4.62		17	0.08	25	5.00		45	0.08	15	5.00		14	0.07	70	70.5
21	48	4.62		22	.08	37	4.62		50	.08	27	5.00		18	.08	69	69.5
22	5 1	4.62		27	.08	50	4.62		55	.08	39	5.00		23	.08	68	68.5
23	14	4.62		32	.10	5 3	5.00	78	0	.08	51	5.00		28	.08	67	67.5
24	27	4.62		38	.10	15	5.00		5	.10	5 3	5.00		33	.08	66	66.5
25	40	4.62		44	0.10	27	5.00		11	0.10	15	5.00		38	0.10	65	65.6
26	53	5.00		50	.10	39	5.00		17	.10	27	5.45		44	.10	64	64.6
27	6 5	4.62		56	.10	51	5.00		23	.10	38	5.00		50	.10	63	63.6
28	18	5.00	78	2	.10	6 3	5.00		29	.10	50	5.00		56	.10	62	62.6
29	30	5.00		8	.12	15	5.00		35	.10	6 2	5.45	79	2	.10	61	61.6
30	42	5.00		15	0.12	27	5.00		41	0.12	13	5.45		8	0.10	60	60.6
31	54	5.00		22	.13	39	5.00		48	.12	24	5.45		14	.12	59	59.7
32	7 6	5.00		30	.12	51	5.45		55	.13	35	5.45		21	.12	58	58.7
33	18	5.00		37	.13	7 2	5.00	79	3	.12	46	5.45		28	.12	57	57.7
34	30	5.00		45	.12	14	5.45		10	.12	57	5.45		35	.12	56	56.7
35	42	5.45		52	0.13	25	5.45		17	0.13	7 8	5.45		42	0.13	55	55.7
36	53	5.00	79	0	.15	36	5.45		25	.13	19	6.00		50	.13	54	54.7
37	8 5	5.45		9	.13	47	5.45		33	.13	29	5.45		58	.12	53	53.7
38	16	5.45		17	.15	58	6.00		41	.15	40	6.00	80	5	.13	52	52.7
39	27	5.45		26	.15	8 8	5.45		50	.13	50	6.00		13	.15	51	51.7
40	38	5.45		35	0.15	19	6.00		58	0.15	8 0	6.00		22	0.13	50	50.7
41	49	6.00		44	.15	29	6.00	80	7	.15	10	6.00		30	.15	49	49.7
42	59	5.45		53	.15	39	6.00		16	.15	20	6.67		39	.13	48	48.7
43	9 10	6.00	80	2	.17	49	6.00		25	.15	29	6.00		47	.15	47	47.7
44	20	6.00		12	.17	59	6.00		34	.15	39	6.67		56	.15	46	46.7
45	30			22		9 9			43		48		81	5		45	45.7
t	a	60′/Δ		b	Δ/60′	a	60′/Δ		b	Δ/60′	a	60′/Δ		b	Δ/60′		a
	d = 76° 30′					d = 77° 0′					d = 77° 30′						

b / B	$a = 76° 30'$ h	d	60′/Δ	Z	t	Δ/60′	$a = 77° 0'$ h	d	60′/Δ	Z	t	Δ/60′	$a = 77° 30'$ h	d	60′/Δ	Z	t	Δ/60′	c / C	a / β
°	°	′		°	′		°	′		°	′		°	′		°	′		°	°
45	9	30	6.00	80	22	0.17	9	9	6.00	80	43	0.17	8	48	6.67	81	5	0.17	45	45.7
46		40	6.00		32	.17		19	6.67		53	.17		57	6.67		15	.15	44	44.7
47		50	6.00		42	.17		28	6.67	81	3	.17	9	6	6.67		24	.17	43	43.7
48	10	0	6.67		52	.18		37	6.67		13	.17		15	6.67		34	.15	42	42.7
49		9	6.67	81	3	.18		46	6.67		23	.17		24	6.67		43	.17	41	41.7
50		18	6.67		14	0.18		55	6.67		33	0.18		33	7.50		53	0.17	40	40.7
51		27	6.67		25	.18	10	4	6.67		44	.18		41	7.50	82	3	.18	39	39.7
52		36	6.67		36	.18		13	7.50		55	.18		49	7.50		14	.17	38	38.7
53		45	7.50		47	.18		21	7.50	82	6	.18		57	7.50		24	.18	37	37.7
54		53	7.50		58	.18		29	7.50		17	.18	10	5	7.50		35	.17	36	36.7
55	11	1	7.50	82	9	0.20		37	7.50		28	0.18		13	8.57		45	0.18	35	35.7
56		9	7.50		21	.20		45	7.50		39	.18		20	8.57		56	.18	34	34.7
57		17	7.50		33	.20		53	8.57		50	.18		27	8.57	83	7	.18	33	33.7
58		25	7.50		45	.20	11	0	8.57	83	1	.20		34	8.57		18	.18	32	32.7
59		33	8.57		57	.20		7	8.57		13	.20		41	8.57		29	.18	31	31.7
60		40	8.57	83	9	0.22		14	8.57		25	0.20		48	8.57		40	0.20	30	30.6
61		47	8.57		22	.20		21	8.57		37	.20		55	10.0		52	.18	29	29.6
62		54	8.57		34	.22		28	10.0		49	.20	11	1	10.0	84	3	.20	28	28.6
63	12	1	10.0		47	.20		34	10.0	84	1	.20		7	10.0		15	.20	27	27.6
64		7	10.0		59	.22		40	10.0		13	.20		13	10.0		27	.20	26	26.6
65		13	10.0	84	12	0.22		46	10.0		25	0.22		19	12.0		39	0.20	25	25.6
66		19	10.0		25	.22		52	12.0		38	.22		24	12.0		51	.20	24	24.6
67		25	12.0		38	.23		57	12.0		51	.20		29	12.0	85	3	.20	23	23.5
68		30	12.0		52	.22	12	2	12.0	85	3	.22		34	12.0		15	.20	22	22.5
69		35	12.0	85	5	.22		7	12.0		16	.22		39	12.0		27	.22	21	21.5
70		40	12.0		18	0.23		12	12.0		29	0.22		44	12.0		40	0.20	20	20.5
71		45	12.0		32	.22		17	15.0		42	.22		49	15.0		52	.22	19	19.5
72		50	15.0		45	.23		21	15.0		55	.22		53	15.0	86	5	.20	18	18.4
73		54	15.0		59	.23		25	15.0	86	8	.23		57	15.0		17	.22	17	17.4
74		58	15.0	86	13	.23		29	15.0		22	.22	12	1	20.0		30	.22	16	16.4
75	13	2	15.0		27	0.23		33	15.0		35	0.22		4	20.0		43	0.22	15	15.4
76		6	20.0		41	.23		37	20.0		48	.23		7	20.0		56	.22	14	14.4
77		9	20.0		55	.23		40	20.0	87	2	.22		10	20.0	87	9	.22	13	13.3
78		12	20.0	87	9	.23		43	20.0		15	.23		13	20.0		22	.22	12	12.3
79		15	20.0		23	.23		46	30.0		29	.22		16	30.0		35	.22	11	11.3
80		18	30.0		37	0.23		48	30.0		42	0.23		18	30.0		48	0.22	10	10.3
81		20	30.0		51	.23		50	30.0		56	.23		20	30.0	88	1	.22	9	9.2
82		22	30.0	88	5	.23		52	30.0	88	10	.22		22	30.0		14	.22	8	8.2
83		24	30.0		19	.25		54	30.0		23	.23		24	30.0		27	.22	7	7.2
84		26	60.0		34	.23		56	60.0		37	.23		26	60.0		40	.23	6	6.2
85		27	60.0		48	0.23		57	60.0		51	0.23		27	60.0		54	0.22	5	5.1
86		28	60.0	89	2	.25		58	60.0	89	5	.22		28	60.0	89	7	.22	4	4.1
87		29	60.0		17	.23		59	60.0		18	.23		29	60.0		20	.22	3	3.1
88		30	—		31	.23	13	0	—		32	.23		30	—		33	.23	2	2.1
89		30	—		45	.25		0	—		46	.23		30	—		47	.22	1	1.0
90		30		90	0			0		90	0			30		90	0		0	0.0
t	a	60′/Δ	b	Δ/60′			a	60′/Δ	b	Δ/60′			a	60′/Δ	b	Δ/60′				a
	$d = 76° 30'$						$d = 77° 0'$						$d = 77° 30'$							

b / B	a = 78° 0′				a = 78° 30′				a = 79° 0′				c / C	a / β
	h \ d	60′/Δ	Z \ t	Δ/60′	h \ d	60′/Δ	Z \ t	Δ/60′	h \ d	60′/Δ	Z \ t	Δ/60′		
	° ′		° ′		° ′		° ′		° ′		° ′			
0	0 0	5.00	78 0	0.00	0 0	5.00	78 30	0.00	0 0	5.45	79 0	0.00	90	90.0
1	12	4.62	0	.00	12	5.00	30	.00	11	5.00	0	.00	89	89.0
2	25	5.00	0	.02	24	5.00	30	.02	23	5.45	0	.02	88	88.0
3	37	4.62	1	.02	36	5.00	31	.02	34	5.00	1	.02	87	87.1
4	50	5.00	2	.02	48	5.00	32	.02	46	5.45	2	.02	86	86.1
5	1 2	4.62	3	0.02	1 0	5.00	33	0.02	57	5.00	3	0.02	85	85.1
6	15	5.00	4	.02	12	5.00	34	.02	1 9	5.45	4	.02	84	84.1
7	27	5.00	5	.03	24	5.45	35	.03	20	5.45	5	.02	83	83.1
8	39	4.62	7	.03	35	5.00	37	.02	31	5.00	6	.03	82	82.2
9	52	5.00	9	.03	47	5.00	38	.03	43	5.45	8	.03	81	81.2
10	2 4	4.62	11	0.03	59	5.00	40	0.03	54	5.45	10	0.03	80	80.2
11	17	5.00	13	.03	2 11	5.00	42	.05	2 5	5.45	12	.03	79	79.2
12	29	5.00	15	.05	23	5.45	45	.03	16	5.00	14	.03	78	78.2
13	41	5.00	18	.05	34	5.00	47	.05	28	5.45	16	.05	77	77.3
14	53	5.00	21	.05	46	5.00	50	.05	39	5.45	19	.05	76	76.3
15	3 5	5.00	24	0.05	58	5.45	53	0.05	50	5.45	22	0.05	75	75.3
16	17	5.00	27	.05	3 9	5.00	56	.05	3 1	5.45	25	.05	74	74.3
17	29	5.00	30	.07	21	5.45	59	.07	12	5.45	28	.05	73	73.3
18	41	5.00	34	.07	32	5.45	79 3	.07	23	5.45	31	.07	72	72.3
19	53	5.00	38	.07	43	5.00	7	.07	34	5.45	35	.07	71	71.4
20	4 5	5.00	42	0.07	55	5.45	11	0.07	45	6.00	39	0.07	70	70.4
21	17	5.45	46	.08	4 6	5.45	15	.07	55	5.45	43	.07	69	69.4
22	28	5.00	51	.08	17	5.45	19	.08	4 6	5.45	47	.07	68	68.4
23	40	5.45	56	.08	28	5.45	24	.07	17	6.00	51	.08	67	67.4
24	51	5.00	79 1	.08	39	5.45	28	.08	27	5.45	56	.08	66	66.4
25	5 3	5.45	6	0.08	50	5.45	33	0.08	38	6.00	80 1	0.08	65	65.4
26	14	5.45	11	.08	5 1	5.45	38	.08	48	6.00	6	.08	64	64.5
27	25	5.45	16	.10	12	6.00	43	.10	58	6.00	11	.08	63	63.5
28	36	5.45	22	.10	22	5.45	49	.08	5 8	6.00	16	.08	62	62.5
29	47	5.45	28	.10	33	6.00	54	.10	18	6.00	21	.10	61	61.5
30	58	5.45	34	0.10	43	5.45	80 0	0.10	28	6.00	27	0.10	60	60.5
31	6 9	5.45	40	.12	54	6.00	6	.10	38	6.00	33	.10	59	59.5
32	20	6.00	47	.12	6 4	6.00	12	.12	48	6.00	39	.10	58	58.5
33	30	5.45	54	.12	14	6.00	19	.10	58	6.00	45	.10	57	57.5
34	41	6.00	80 1	.12	24	6.00	25	.12	6 8	6.67	51	.10	56	56.5
35	51	6.00	8	0.12	34	6.00	32	0.12	17	6.00	57	0.12	55	55.5
36	7 1	6.00	15	.12	44	6.00	39	.12	27	6.67	81 4	.12	54	54.6
37	11	6.00	22	.12	54	6.67	46	.12	36	6.67	11	.12	53	53.6
38	21	6.00	29	.13	7 3	6.00	53	.13	45	6.67	18	.12	52	52.6
39	31	6.00	37	.13	13	6.67	81 1	.12	54	6.67	25	.12	51	51.6
40	41	6.00	45	0.13	22	6.67	8	0.13	7 3	6.67	32	0.12	50	50.6
41	51	6.67	53	.13	31	6.67	16	.13	12	7.50	39	.13	49	49.6
42	8 0	6.67	81 1	.15	40	6.67	24	.13	20	6.67	47	.13	48	48.6
43	9	6.67	10	.13	49	6.67	32	.13	29	7.50	55	.12	47	47.6
44	18	6.67	18	.15	58	7.50	40	.15	37	7.50	82 2	.13	46	46.6
45	27		27		8 6		49		45		10		45	45.6
t	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′		a
	d = 78° 0′				d = 78° 30′				d = 79° 0′					

0.213 0.203 0.194

b / B	a = 78° 0′					a = 78° 30′					a = 79° 0′					c / C	α / β
	h \ d	60′/Δ	Z \ t	Δ/60′		h \ d	60′/Δ	Z \ t	Δ/60′		h \ d	60′/Δ	Z \ t	Δ/60′			
°	° ′		° ′			° ′		° ′			° ′		° ′			°	°
45	8 27	6.67	81 27	0.15		8 6	6.67	81 49	0.13		7 45	7.50	82 10	0.15		45	45.6
46	36	6.67	36	.15		15	7.50	57	.15		53	7.50	19	.13		44	44.6
47	45	7.50	45	.15		23	7.50	82 6	.15		8 1	7.50	27	.13		43	43.6
48	53	6.67	54	.17		31	7.50	15	.15		9	7.50	35	.15		42	42.6
49	9 2	7.50	82 4	.15		39	7.50	24	.15		17	8.57	44	.15		41	41.6
50	10	7.50	13	0.17		47	7.50	33	0.15		24	7.50	53	0.15		40	40.6
51	18	7.50	23	.17		55	7.50	42	.15		32	8.57	83 2	.15		39	39.6
52	26	7.50	33	.17		9 3	8.57	51	.17		39	8.57	11	.15		38	38.6
53	34	8.57	43	.17		10	8.57	83 1	.17		46	8.57	20	.15		37	37.6
54	41	8.57	53	.17		17	8.57	11	.17		53	8.57	29	.15		36	36.6
55	48	8.57	83 3	0.17		24	8.57	21	0.17		9 0	10.0	38	0.17		35	35.5
56	55	8.57	13	.18		31	8.57	31	.17		6	8.57	48	.15		34	34.5
57	10 2	8.57	24	.17		38	10.0	41	.17		13	10.0	57	.17		33	33.5
58	9	8.57	34	.18		44	10.0	51	.17		19	10.0	84 7	.17		32	32.5
59	16	8.57	45	.18		50	10.0	84 1	.17		25	10.0	17	.17		31	31.5
60	23	10.0	56	0.18		56	10.0	11	0.18		31	10.0	27	0.17		30	30.5
61	29	10.0	84 7	.18		10 2	10.0	22	.18		37	12.0	37	.17		29	29.5
62	35	10.0	18	.18		8	10.0	33	.17		42	12.0	47	.17		28	28.5
63	41	12.0	29	.20		14	12.0	43	.18		47	12.0	57	.18		27	27.5
64	46	10.0	41	.18		19	12.0	54	.18		52	12.0	85 8	.17		26	26.5
65	52	12.0	52	0.20		24	12.0	85 5	0.18		57	12.0	18	0.18		25	25.4
66	57	12.0	85 4	.18		29	12.0	16	.18		10 2	12.0	29	.17		24	24.4
67	11 2	12.0	15	.20		34	12.0	27	.18		7	15.0	39	.18		23	23.4
68	7	12.0	27	.20		39	12.0	38	.20		11	15.0	50	.18		22	22.4
69	12	15.0	39	.20		44	15.0	50	.18		15	15.0	86 1	.18		21	21.4
70	16	15.0	51	0.20		48	15.0	86 1	0.20		19	15.0	12	0.18		20	20.4
71	20	15.0	86 3	.20		52	15.0	13	.18		23	15.0	23	.18		19	19.4
72	24	15.0	15	.20		56	15.0	24	.20		27	15.0	34	.18		18	18.3
73	28	15.0	27	.20		11 0	20.0	36	.18		31	20.0	45	.18		17	17.3
74	32	20.0	39	.20		3	20.0	47	.20		34	20.0	56	.18		16	16.3
75	35	20.0	51	0.20		6	20.0	59	0.20		37	20.0	87 7	0.18		15	15.3
76	38	20.0	87 3	.22		9	20.0	87 11	.20		40	20.0	18	.20		14	14.3
77	41	20.0	16	.20		12	20.0	23	.20		43	20.0	30	.18		13	13.3
78	44	20.0	28	.22		15	30.0	35	.20		46	30.0	41	.20		12	12.2
79	47	30.0	41	.20		17	30.0	47	.20		48	30.0	53	.18		11	11.2
80	49	30.0	53	0.22		19	30.0	59	0.20		50	30.0	88 4	0.18		10	10.2
81	51	30.0	88 6	.20		21	30.0	88 11	.20		52	30.0	15	.20		9	9.2
82	53	30.0	18	.22		23	30.0	23	.20		54	60.0	27	.20		8	8.2
83	55	60.0	31	.22		25	60.0	35	.20		55	60.0	39	.18		7	7.1
84	56	60.0	44	.20		26	60.0	47	.20		56	60.0	50	.20		6	6.1
85	57	60.0	56	0.22		27	60.0	59	0.20		57	60.0	89 2	0.18		5	5.1
86	58	60.0	89 9	.22		28	60.0	89 11	.20		58	60.0	13	.20		4	4.1
87	59	60.0	22	.20		29	60.0	23	.20		59	60.0	25	.20		3	3.1
88	12 0	—	34	.22		30	—	35	.22		11 0	—	37	.18		2	2.0
89	0	—	47	.22		30	—	48	.20		0	—	48	.20		1	1.0
90	0		90 0			30		90 0			0		90 0			0	0.0

t	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′		a
	d = 78° 0′				d = 78° 30′				d = 79° 0′					

b / B	a = 79° 30′						a = 80° 0′						a = 80° 30′						c / C	a / β
	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′		
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
0	0 0	5.45		79 30		0.00	0 0	6.00		80 0		0.00	0 0	6.00		80 30		0.00	90	90.0
1	11	5.45		30		.00	10	5.45		0		.00	10	6.00		30		.00	89	89.0
2	22	5.45		30		.02	21	6.00		0		.02	20	6.00		30		.02	88	88.0
3	33	5.45		31		.00	31	5.45		1		.00	30	6.00		31		.00	87	87.0
4	44	5.45		31		.02	42	6.00		1		.02	40	6.00		31		.02	86	86.1
5	55	5.45		32		0.02	52	6.00		2		0.02	50	6.67		32		0.02	85	85.1
6	1 6	5.45		33		.02	1 2	5.45		3		.02	59	6.00		33		.02	84	84.1
7	17	6.00		34		.03	13	6.00		4		.03	1 9	6.00		34		.02	83	83.1
8	27	5.45		36		.03	23	6.00		6		.02	19	6.00		35		.03	82	82.1
9	38	5.45		38		.02	33	5.45		7		.03	29	6.00		37		.02	81	81.1
10	49	5.45		39		0.03	44	6.00		9		0.03	39	6.67		38		0.03	80	80.1
11	2 0	6.00		41		.03	54	6.00		11		.03	48	6.00		40		.03	79	79.2
12	10	5.45		43		.05	2 4	6.00		13		.03	58	6.00		42		.03	78	78.2
13	21	5.45		46		.03	14	6.00		15		.03	2 8	6.67		44		.03	77	77.2
14	32	6.00		48		.05	24	6.00		17		.05	17	6.00		46		.05	76	76.2
15	42	5.45		51		0.05	34	6.00		20		0.05	27	6.67		49		0.05	75	75.2
16	53	6.00		54		.05	44	6.00		23		.05	36	6.00		52		.03	74	74.2
17	3 3	5.45		57		.05	54	6.00		26		.05	46	6.67		54		.05	73	73.2
18	14	6.00		80 0		.05	3 4	6.00		29		.05	55	6.00		57		.05	72	72.3
19	24	6.00		3		.07	14	6.00		32		.05	3 5	6.67		81 0		.07	71	71.3
20	34	5.45		7		0.07	24	6.00		35		0.07	14	6.00		4		0.05	70	70.3
21	45	6.00		11		.07	34	6.00		39		.07	24	6.67		7		.07	69	69.3
22	55	6.00		15		.07	44	6.67		43		.07	33	6.67		11		.07	68	68.3
23	4 5	6.00		19		.07	53	6.00		47		.07	42	6.67		15		.07	67	67.3
24	15	6.00		23		.08	4 3	6.00		51		.07	51	6.67		19		.07	66	66.3
25	25	6.00		28		0.08	13	6.67		55		0.08	4 0	6.67		23		0.07	65	65.3
26	35	6.00		33		.07	22	6.67		81 0		.07	9	6.67		27		.07	64	64.3
27	45	6.00		37		.08	31	6.00		4		.08	18	6.67		31		.08	63	63.4
28	55	6.67		42		.08	41	6.67		9		.08	27	6.67		36		.07	62	62.4
29	5 4	6.00		47		.10	50	6.67		14		.08	36	7.50		40		.08	61	61.4
30	14	6.67		53		0.08	59	6.67		19		0.08	44	6.67		45		0.08	60	60.4
31	23	6.00		58		.10	5 8	6.67		24		.10	53	7.50		50		.08	59	59.4
32	33	6.67		81 4		.10	17	6.67		30		.08	5 1	7.50		55		.10	58	58.4
33	42	6.67		10		.10	26	7.50		35		.10	9	6.67		82 1		.08	57	57.4
34	51	6.67		16		.10	34	6.67		41		.10	18	7.50		6		.10	56	56.4
35	6 0	6.67		22		0.10	43	6.67		47		0.10	26	7.50		12		0.08	55	55.4
36	9	6.67		28		.12	52	7.50		53		.10	34	7.50		17		.10	54	54.4
37	18	6.67		35		.10	6 0	7.50		59		.10	42	7.50		23		.10	53	53.4
38	27	7.50		41		.12	8	7.50		82 5		.12	50	7.50		29		.10	52	52.4
39	35	6.67		48		.12	16	7.50		12		.10	58	8.57		35		.12	51	51.4
40	44	7.50		55		0.12	24	7.50		18		0.12	6 5	7.50		42		0.10	50	50.4
41	52	7.50		82 2		.12	32	7.50		25		.12	13	8.57		48		.12	49	49.4
42	7 0	7.50		9		.13	40	7.50		32		.12	20	7.50		55		.10	48	48.4
43	8	7.50		17		.12	48	7.50		39		.12	28	8.57		83 1		.12	47	47.4
44	16	7.50		24		.13	56	8.57		46		.13	35	8.57		8		.12	46	46.4
45	24			32			7 3			54			42			15			45	45.4

t	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′		α
	d = 79° 30′				d = 80° 0′				d = 80° 30′					

b / B	a = 79° 30′					a = 80° 0′					a = 80° 30′					c / C	a / β
	h	d	60′/Δ	Z	t	h	d	60′/Δ	Z	t	h	d	60′/Δ	Z	t		
°	° ′			° ′	Δ/60′	° ′			° ′	Δ/60′	° ′			° ′	Δ/60′	°	°
45	7 24	7.50		82 32	0.13	7 3	7.50		82 54	0.12	6 42	8.57		83 15	0.12	45	45.4
46	32	7.50		40	.13	11	8.57		83 1	.13	49	8.57		22	.12	44	44.4
47	40	8.57		48	.13	18	8.57		9	.12	56	8.57		29	.13	43	43.4
48	47	8.57		56	.13	25	8.57		16	.13	7 3	10.0		37	.12	42	42.4
49	54	8.57		83 4	.13	32	8.57		24	.13	9	8.57		44	.13	41	41.4
50	8 1	8.57		12	0.15	39	10.0		32	0.13	16	10.0		52	0.12	40	40.4
51	8	8.57		21	.13	45	8.57		40	.13	22	10.0		59	.13	39	39.4
52	15	8.57		29	.15	52	10.0		48	.15	28	10.0		84 7	.13	38	38.4
53	22	8.57		38	.15	58	10.0		57	.13	34	10.0		15	.13	37	37.4
54	29	10.0		47	.15	8 4	10.0		84 5	.13	40	10.0		23	.13	36	36.4
55	35	10.0		56	0.15	10	10.0		13	0.15	46	10.0		31	0.13	35	35.4
56	41	10.0		84 5	.15	16	10.0		22	.15	52	10.0		39	.13	34	34.4
57	47	10.0		14	.15	22	10.0		31	.15	58	12.0		47	.15	33	33.4
58	53	10.0		23	.17	28	10.0		40	.15	8 3	12.0		56	.13	32	32.4
59	59	10.0		33	.15	34	12.0		49	.15	8	12.0		85 4	.15	31	31.4
60	9 5	10.0		42	0.17	39	12.0		58	0.15	13	12.0		13	0.15	30	30.4
61	11	12.0		52	.15	44	12.0		85 7	.15	18	12.0		22	.13	29	29.4
62	16	12.0		85 1	.17	49	12.0		16	.15	23	12.0		30	.15	28	28.4
63	21	12.0		11	.17	54	12.0		25	.17	28	15.0		39	.15	27	27.4
64	26	12.0		21	.17	59	12.0		35	.15	32	15.0		48	.15	26	26.3
65	31	15.0		31	0.17	9 4	15.0		44	0.17	36	15.0		57	0.15	25	25.3
66	35	15.0		41	.17	8	15.0		54	.17	40	15.0		86 6	.15	24	24.3
67	39	15.0		51	.18	12	15.0		86 4	.15	44	15.0		15	.17	23	23.3
68	43	15.0		86 2	.17	16	15.0		13	.17	48	15.0		25	.15	22	22.3
69	47	15.0		12	.17	20	15.0		23	.17	52	15.0		34	.15	21	21.3
70	51	15.0		22	0.18	24	20.0		33	0.17	56	20.0		43	0.17	20	20.3
71	55	15.0		33	.17	27	20.0		43	.17	59	20.0		53	.15	19	19.3
72	59	20.0		43	.18	30	20.0		53	.17	9 2	20.0		87 2	.17	18	18.3
73	10 2	20.0		54	.17	33	20.0		87 3	.17	5	20.0		12	.17	17	17.2
74	5	20.0		87 4	.18	36	20.0		13	.17	8	20.0		22	.15	16	16.2
75	8	20.0		15	0.18	39	20.0		23	0.17	11	30.0		31	0.17	15	15.2
76	11	20.0		26	.18	42	20.0		33	.18	13	30.0		41	.17	14	14.2
77	14	30.0		37	.17	45	30.0		44	.17	15	30.0		51	.15	13	13.2
78	16	30.0		47	.18	47	30.0		54	.17	17	30.0		88 0	.17	12	12.2
79	18	30.0		58	.18	49	30.0		88 4	.18	19	30.0		10	.17	11	11.2
80	20	30.0		88 9	0.18	51	30.0		15	0.17	21	30.0		20	0.17	10	10.2
81	22	30.0		20	.18	53	60.0		25	.18	23	30.0		30	.17	9	9.1
82	24	60.0		31	.18	54	60.0		36	.17	25	60.0		40	.17	8	8.1
83	25	60.0		42	.18	55	60.0		46	.18	26	60.0		50	.17	7	7.1
84	26	60.0		53	.18	56	60.0		57	.17	27	60.0		89 0	.17	6	6.1
85	27	60.0		89 4	0.18	57	60.0		89 7	0.18	28	60.0		10	0.17	5	5.1
86	28	60.0		15	.20	58	60.0		18	.17	29	—		20	.17	4	4.1
87	29	60.0		27	.18	59	60.0		28	.18	29	60.0		30	.17	3	3.0
88	30	—		38	.18	10 0	—		39	.17	30	—		40	.17	2	2.0
89	30	—		49	.18	0	—		49	.18	30	—		50	.17	1	1.0
90	30			90 0		0			90 0		30			90 0		0	0.0
t	a	60′/Δ		b	Δ/60′	a	60′/Δ		b	Δ/60′	a	60′/Δ		b	Δ/60′		a
	d = 79° 30′					d = 80° 0′					d = 80° 30′						

b / B	a = 81° 0′					a = 81° 30′					a = 82° 0′					c / C	a / β
	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′		
°	° ′			° ′			° ′			° ′			° ′			° ′			°	°
0	0 0	6.67		81 0		0.00	0 0	6.67		81 30		0.00	0 0	7.50		82 0		0.00	90	90.0
1	9	6.00		0		.00	9	6.67		30		.00	8	6.67		0		.00	89	89.0
2	19	6.67		0		.02	18	6.67		30		.02	17	7.50		0		.02	88	88.0
3	28	6.00		1		.00	27	7.50		31		.00	25	7.50		1		.00	87	87.0
4	38	6.67		1		.02	35	6.67		31		.02	33	6.67		1		.02	86	86.0
5	47	6.67		2		0.02	44	6.67		32		0.02	42	7.50		2		0.02	85	85.1
6	56	6.00		3		.02	53	6.67		33		.02	50	7.50		3		.02	84	84.1
7	1 6	6.67		4		.02	1 2	6.67		34		.02	58	6.67		4		.02	83	83.1
8	15	6.67		5		.02	11	6.67		35		.02	1 7	7.50		5		.02	82	82.1
9	24	6.67		6		.03	20	7.50		36		.03	15	7.50		6		.02	81	81.1
10	33	6.00		8		0.03	28	6.67		38		0.02	23	7.50		7		0.03	80	80.1
11	43	6.67		10		.03	37	6.67		39		.03	31	6.67		9		.02	79	79.1
12	52	6.67		12		.03	46	7.50		41		.03	40	7.50		10		.03	78	78.1
13	2 1	6.67		14		.03	54	6.67		43		.03	48	7.50		12		.03	77	77.1
14	10	6.67		16		.03	2 3	6.67		45		.03	56	7.50		14		.03	76	76.1
15	19	6.67		18		0.03	12	7.50		47		0.03	2 4	7.50		16		0.03	75	75.2
16	28	6.67		20		.05	20	6.67		49		.05	12	7.50		18		.05	74	74.2
17	37	6.67		23		.05	29	7.50		52		.05	20	7.50		21		.03	73	73.2
18	46	6.67		26		.05	37	6.67		55		.03	28	7.50		23		.05	72	72.2
19	55	6.67		29		.05	46	7.50		57		.05	36	7.50		26		.05	71	71.2
20	3 4	6.67		32		0.05	54	7.50		82 0		0.05	44	7.50		29		0.05	70	70.2
21	13	6.67		35		.07	3 2	7.50		3		.07	52	8.57		32		.05	69	69.2
22	22	7.50		39		.05	10	6.67		7		.05	59	7.50		35		.05	68	68.2
23	30	6.67		42		.07	19	7.50		10		.05	3 7	7.50		38		.05	67	67.2
24	39	7.50		46		.07	27	7.50		13		.07	15	8.57		41		.05	66	66.2
25	47	6.67		50		0.07	35	7.50		17		0.07	22	7.50		44		0.07	65	65.2
26	56	6.67		54		.07	43	7.50		21		.07	30	8.57		48		.07	64	64.2
27	4 5	7.50		58		.07	51	7.50		25		.07	37	7.50		52		.07	63	63.3
28	13	7.50		82 2		.08	59	7.50		29		.07	45	8.57		56		.07	62	62.3
29	21	7.50		7		.07	4 7	8.57		33		.07	52	8.57		83 0		.07	61	61.3
30	29	7.50		11		0.08	14	7.50		37		0.08	59	7.50		4		0.07	60	60.3
31	37	7.50		16		.08	22	7.50		42		.08	4 7	8.57		8		.07	59	59.3
32	45	7.50		21		.08	30	8.57		47		.07	14	8.57		12		.08	58	58.3
33	53	7.50		26		.08	37	7.50		51		.08	21	8.57		17		.07	57	57.3
34	5 1	7.50		31		.08	45	8.57		56		.08	28	8.57		21		.08	56	56.3
35	9	7.50		36		0.10	52	8.57		83 1		0.08	35	8.57		26		0.08	55	55.3
36	17	8.57		42		.08	59	8.57		6		.10	42	10.0		31		.08	54	54.3
37	24	7.50		47		.10	5 6	8.57		12		.08	48	8.57		36		.08	53	53.3
38	32	8.57		53		.10	13	8.57		17		.08	55	8.57		41		.08	52	52.3
39	39	8.57		59		.10	20	8.57		22		.10	5 2	10.0		46		.08	51	51.3
40	46	8.57		83 5		0.10	27	8.57		28		0.10	8	10.0		51		0.10	50	50.3
41	53	8.57		11		.10	34	8.57		34		.10	14	8.57		57		.08	49	49.3
42	6 0	8.57		17		.10	41	10.0		40		.10	21	10.0		84 2		.10	48	48.3
43	7	8.57		23		.12	47	8.57		46		.10	27	10.0		8		.10	47	47.3
44	14	8.57		30		.12	54	10.0		52		.10	33	10.0		14		.10	46	46.3
45	21			37			6 0			58			39			20			45	45.3
t	a	60′/Δ		b		Δ/60′	a	60′/Δ		b		Δ/60′	a	60′/Δ		b		Δ/60′		a
	d = 81° 0′						d = 81° 30′						d = 82° 0′							

b / B	a = 81° 0′					a = 81° 30′					a = 82° 0′					c / C	a / β
	h	d	60′/Δ	Z	t	h	d	60′/Δ	Z	t	h	d	60′/Δ	Z	t		
°	° ′			° ′	Δ/60′	° ′			° ′	Δ/60′	° ′			° ′	Δ/60′	°	°
45	6 21	8.57		83 37	0.10	6 0	10.0		83 58	0.10	5 39	10.0		84 20	0.10	45	45.3
46	28	10.0		43	.12	6	10.0		84 4	.12	45	10.0		26	.10	44	44.3
47	34	8.57		50	.12	12	10.0		11	.10	51	12.0		32	.10	43	43.3
48	41	10.0		57	.12	18	10.0		17	.12	56	10.0		38	.10	42	42.3
49	47	10.0		84 4	.12	24	10.0		24	.12	6 2	12.0		44	.10	41	41.3
50	53	10.0		11	0.12	30	10.0		31	0.12	7	10.0		50	0.12	40	40.3
51	59	10.0		18	.13	36	12.0		38	.12	13	12.0		57	.10	39	39.3
52	7 5	10.0		26	.12	41	10.0		45	.12	18	12.0		85 3	.12	38	38.3
53	11	12.0		33	.13	47	12.0		52	.12	23	12.0		10	.12	37	37.3
54	16	10.0		41	.13	52	12.0		59	.12	28	12.0		17	.10	36	36.3
55	22	12.0		49	0.12	57	12.0		85 6	0.12	33	12.0		23	0.12	35	35.3
56	27	12.0		56	.13	7 2	12.0		13	.13	38	15.0		30	.12	34	34.3
57	32	12.0		85 4	.13	7	12.0		21	.12	42	12.0		37	.12	33	33.3
58	37	12.0		12	.13	12	12.0		28	.13	47	15.0		44	.13	32	32.3
59	42	12.0		20	.13	17	12.0		36	.13	51	15.0		52	.12	31	31.3
60	47	12.0		28	0.15	22	15.0		44	0.12	55	15.0		59	0.12	30	30.3
61	52	12.0		37	.13	26	15.0		51	.13	59	15.0		86 6	.12	29	29.3
62	57	15.0		45	.13	30	15.0		59	.13	7 3	15.0		13	.13	28	28.3
63	8 1	15.0		53	.15	34	15.0		86 7	.13	7	15.0		21	.12	27	27.3
64	5	15.0		86 2	.13	38	15.0		15	.13	11	15.0		28	.13	26	26.3
65	9	15.0		10	0.15	42	15.0		23	0.13	15	15.0		36	0.13	25	25.2
66	13	15.0		19	.15	46	20.0		31	.13	19	20.0		44	.12	24	24.2
67	17	15.0		28	.13	49	15.0		39	.15	22	20.0		51	.13	23	23.2
68	21	20.0		36	.15	53	20.0		48	.13	25	20.0		59	.13	22	22.2
69	24	20.0		45	.15	56	20.0		56	.13	28	20.0		87 7	.13	21	21.2
70	27	20.0		54	0.15	59	20.0		87 4	0.15	31	20.0		15	0.13	20	20.2
71	30	20.0		87 3	.15	8 2	20.0		13	.13	34	20.0		23	.13	19	19.2
72	33	20.0		12	.15	5	20.0		21	.15	37	30.0		31	.13	18	18.2
73	36	20.0		21	.15	8	30.0		30	.13	39	30.0		39	.13	17	17.2
74	39	20.0		30	.15	10	20.0		38	.15	41	30.0		47	.13	16	16.2
75	42	30.0		39	0.15	13	30.0		47	0.15	43	30.0		55	0.13	15	15.2
76	44	30.0		48	.17	15	30.0		56	.13	45	30.0		88 3	.13	14	14.2
77	46	30.0		58	.15	17	30.0		88 4	.15	47	30.0		11	.15	13	13.1
78	48	30.0		88 7	.15	19	30.0		13	.15	49	30.0		20	.13	12	12.1
79	50	30.0		16	.15	21	60.0		22	.15	51	30.0		28	.13	11	11.1
80	52	30.0		25	0.17	22	30.0		31	0.15	53	60.0		36	0.13	10	10.1
81	54	60.0		35	.15	24	60.0		40	.13	54	60.0		44	.15	9	9.1
82	55	60.0		44	.17	25	60.0		48	.15	55	60.0		53	.13	8	8.1
83	56	60.0		54	.15	26	60.0		57	.15	56	60.0		89 1	.15	7	7.1
84	57	60.0		89 3	.17	27	60.0		89 6	.15	57	60.0		10	.13	6	6.1
85	58	60.0		13	0.15	28	60.0		15	0.15	58	60.0		18	0.13	5	5.1
86	59	—		22	.15	29	—		24	.15	59	—		26	.15	4	4.0
87	59	60.0		31	.17	29	60.0		33	.15	59	60.0		35	.13	3	3.0
88	9 0	—		41	.15	30	—		42	.15	8 0	—		43	.15	2	2.0
89	0	—		50	.17	30	—		51	.15	0	—		52	.13	1	1.0
90	0			90 0		30			90 0		0			90 0		0	0.0
t	a	60′/Δ		b	Δ/60′	a	60′/Δ		b	Δ/60′	a	60′/Δ		b	Δ/60′		a
	d = 81° 0′					d = 81° 30′					d = 82° 0′						

b / B	a = 82° 30′					a = 83° 0′					a = 83° 30′					c	a
	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	h	d	60′/Δ	Z	t	Δ/60′	C	β
0	0 0	7.50		82 30		0.00	0 0	8.57		83 0		0.00	0 0	8.57		83 30		0.00	90	90.0
1		7.50			30	.00		7.50			0	.00		7.50			30	.00	89	89.0
2		7.50			30	.02		8.57			0	.02		8.57			30	.02	88	88.0
3		8.57			31	.00		8.57			1	.00		8.57			31	.00	87	87.0
4		7.50			31	.02		7.50			1	.02		8.57			31	.00	86	86.0
5		7.50			32	0.00		8.57			2	0.00		8.57			31	0.02	85	85.0
6		7.50			32	.02		8.57			2	.02		10.0			32	.02	84	84.0
7		7.50			33	.02		8.57			3	.02		8.57			33	.02	83	83.1
8	1 3	8.57			34	.02		7.50			4	.02		8.57			34	.02	82	82.1
9		7.50			35	.03	1 6	8.57			5	.02	1 1	8.57			35	.02	81	81.1
10		7.50			37	0.02		8.57			6	0.03		10.0			36	0.02	80	80.1
11		8.57			38	.03		8.57			8	.02		8.57			37	.02	79	79.1
12		7.50			40	.02		8.57			9	.03		8.57			38	.03	78	78.1
13		7.50			41	.03		8.57			11	.02		10.0			40	.02	77	77.1
14		8.57			43	.03		8.57			12	.03		8.57			41	.03	76	76.1
15		7.50			45	0.03		8.57			14	0.03		10.0			43	0.03	75	75.1
16	2 4	8.57			47	.03		8.57			16	.03		8.57			45	.03	74	74.1
17		7.50			49	.05	2 2	8.57			18	.03		10.0			47	.03	73	73.1
18		8.57			52	.03		8.57			20	.05	2 0	8.57			49	.03	72	72.1
19		7.50			54	.05		8.57			23	.03		10.0			51	.03	71	71.1
20		8.57			57	0.03		8.57			25	0.05		8.57			53	0.05	70	70.1
21		8.57			59	.05		8.57			28	.03		10.0			56	.03	69	69.1
22		8.57		83 2		.05		8.57			30	.05		10.0			58	.05	68	68.1
23		7.50			5	.05		10.0			33	.05		10.0		84 1		.03	67	67.2
24	3 3	8.57			8	.07		8.57			36	.05		8.57			3	.05	66	66.2
25		8.57			12	0.05		8.57			39	0.05		10.0			6	0.05	65	65.2
26		8.57			15	.05	3 4	10.0			42	.05		10.0			9	.05	64	64.2
27		8.57			18	.07		8.57			45	.07		10.0			12	.05	63	63.2
28		8.57			22	.07		10.0			49	.05	3 3	10.0			15	.05	62	62.2
29		8.57			26	.07		8.57			52	.07		10.0			18	.07	61	61.2
30		10.0			30	0.07		10.0			56	0.07		10.0			22	0.05	60	60.2
31		8.57			34	.07		10.0		84	0	.05		12.0			25	.07	59	59.2
32		8.57			38	.07		10.0			3	.07		10.0			29	.05	58	58.2
33	4 5	10.0			42	.07		10.0			7	.07		10.0			32	.07	57	57.2
34		8.57			46	.08		10.0			11	.07		12.0			36	.07	56	56.2
35		10.0			51	0.07	4 0	10.0			15	0.08		10.0			40	0.07	55	55.2
36		10.0			55	.08		10.0			20	.07		12.0			44	.07	54	54.2
37		8.57		84 0		.08		10.0			24	.07		10.0			48	.07	53	53.2
38		10.0			5	.07		10.0			28	.08	4 0	12.0			52	.07	52	52.2
39		10.0			9	.08		10.0			33	.08		12.0			56	.08	51	51.2
40		10.0			14	0.08		12.0			38	0.07		10.0		85 1		0.07	50	50.2
41		10.0			19	.10		10.0			42	.08		12.0			5	.08	49	49.2
42	5 1	12.0			25	.08		12.0			47	.08		12.0			10	.07	48	48.2
43	6	10.0			30	.08		10.0			52	.08		12.0			14	.08	47	47.2
44	12	10.0			35	.10		12.0			57	.08		12.0			19	.08	46	46.2
45	18				41			57		85	2			36			24		45	45.2

t	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a	60′/Δ	b	Δ/60′	a
	d = 82° 30′				d = 83° 0′				d = 83° 30′				

0.132 0.123 0.114

b / B	a = 82° 30′					a = 83° 0′					a = 83° 30′					c / C	a / β
	d / h	60′/Δ	t / Z	Δ/60′		d / h	60′/Δ	t / Z	Δ/60′		d / h	60′/Δ	t / Z	Δ/60′			
°	° ′		° ′			° ′		° ′			° ′		° ′			°	°
45	5 18	12.0	84 41	0.08		4 57	12.0	85 2	0.08		4 36	15.0	85 24	0.07		45	45.2
46	23	10.0	46	.10		5 2	12.0	7	.10		40	12.0	28	.08		44	44.2
47	29	12.0	52	.10		7	12.0	13	.08		45	12.0	33	.08		43	43.2
48	34	12.0	58	.10		12	12.0	18	.10		50	15.0	38	.08		42	42.2
49	39	12.0	85 4	.10		17	15.0	24	.08		54	15.0	43	.10		41	41.2
50	44	12.0	10	0.10		21	12.0	29	0.10		58	12.0	49	0.08		40	40.2
51	49	12.0	16	.10		26	12.0	35	.10		5 3	15.0	54	.08		39	39.2
52	54	12.0	22	.10		31	15.0	41	.08		7	15.0	59	.10		38	38.2
53	59	12.0	28	.10		35	12.0	46	.10		11	15.0	86 5	.08		37	37.2
54	6 4	15.0	34	.12		40	15.0	52	.10		15	15.0	10	.10		36	36.2
55	8	12.0	41	0.10		44	15.0	58	0.10		19	15.0	16	0.08		35	35.2
56	13	15.0	47	.12		48	15.0	86 4	.10		23	15.0	21	.10		34	34.2
57	17	15.0	54	.10		52	15.0	10	.12		27	15.0	27	.10		33	33.2
58	21	15.0	86 0	.12		56	15.0	17	.10		31	20.0	33	.08		32	32.2
59	25	15.0	7	.12		6 0	15.0	23	.10		34	15.0	38	.10		31	31.2
60	29	15.0	14	0.12		4	20.0	29	0.12		38	20.0	44	0.10		30	30.2
61	33	15.0	21	.12		7	15.0	36	.10		41	20.0	50	.10		29	29.2
62	37	15.0	28	.12		11	20.0	42	.12		44	20.0	56	.10		28	28.2
63	41	20.0	35	.12		14	20.0	49	.10		47	20.0	87 2	.10		27	27.2
64	44	15.0	42	.12		17	20.0	55	.12		50	20.0	8	.12		26	26.2
65	48	20.0	49	0.12		20	20.0	87 2	0.10		53	20.0	15	0.10		25	25.2
66	51	20.0	56	.12		23	20.0	8	.12		56	20.0	21	.10		24	24.2
67	54	20.0	87 3	.12		26	20.0	15	.12		59	30.0	27	.10		23	23.2
68	57	20.0	10	.13		29	20.0	22	.12		6 1	20.0	33	.12		22	22.2
69	7 0	20.0	18	.12		32	20.0	29	.12		4	20.0	40	.10		21	21.1
70	3	20.0	25	0.13		35	30.0	36	0.12		7	30.0	46	0.12		20	20.1
71	6	30.0	33	.12		37	30.0	43	.12		9	30.0	53	.10		19	19.1
72	8	30.0	40	.13		39	20.0	50	.12		11	30.0	59	.12		18	18.1
73	10	20.0	48	.12		42	30.0	57	.12		13	30.0	88 6	.10		17	17.1
74	13	30.0	55	.13		44	30.0	88 4	.12		15	30.0	12	.12		16	16.1
75	15	30.0	88 3	0.12		46	30.0	11	0.12		17	30.0	19	0.10		15	15.1
76	17	30.0	10	.13		48	60.0	18	.12		19	60.0	25	.12		14	14.1
77	19	60.0	18	.13		49	30.0	25	.12		20	30.0	32	.12		13	13.1
78	20	30.0	26	.13		51	60.0	32	.12		22	60.0	39	.10		12	12.1
79	22	60.0	34	.12		52	30.0	39	.13		23	60.0	45	.12		11	11.1
80	23	60.0	41	0.13		54	60.0	47	0.12		24	60.0	52	0.12		10	10.1
81	24	60.0	49	.13		55	60.0	54	.12		25	60.0	59	.10		9	9.1
82	25	60.0	57	.13		56	60.0	89 1	.13		26	60.0	89 5	.12		8	8.1
83	26	60.0	89 5	.13		57	60.0	9	.12		27	60.0	12	.12		7	7.1
84	27	60.0	13	.13		58	—	16	.12		28	60.0	19	.12		6	6.0
85	28	60.0	21	0.12		58	60.0	23	0.13		29	—	26	0.10		5	5.0
86	29	—	28	.13		59	—	31	.12		29	—	32	.12		4	4.0
87	29	60.0	36	.13		59	60.0	38	.12		29	60.0	39	.12		3	3.0
88	30	—	44	.13		7 0	—	45	.13		30	—	46	.12		2	2.0
89	30	—	52	.13		0	—	53	.12		30	—	53	.12		1	1.0
90	30		90 0			0		90 0			30		90 0			0	0.0
t	a	60′/Δ	b	Δ/60′		a	60′/Δ	b	Δ/60′		a	60′/Δ	b	Δ/60′			a
	d = 82° 30′					d = 83° 0′					d = 83° 30′						

0.105 0.087 0.070

b / B	a = 84° 0′					a = 85° 0′					a = 86° 0′					c / a
	h \ d	60′/Δ	Z \ t	Δ/60′		h \ d	60′/Δ	Z \ t	Δ/60′		h \ d	60′/Δ	Z \ t	Δ/60′		C / β
°	° ′		° ′			° ′		° ′			° ′		° ′			° / °
0	0 0	10.0	84 0	0.00		0 0	12.0	85 0	0.00		0 0	15.0	86 0	0.00		90 / 90.0
1	6	8.57	0	.00		5	12.0	0	.00		4	15.0	0	.00		89 / 89.0
2	13	10.0	0	.00		10	10.0	0	.00		8	12.0	0	.00		88 / 88.0
3	19	10.0	0	.02		16	12.0	0	.02		13	15.0	0	.02		87 / 87.0
4	25	10.0	1	.00		21	12.0	1	.00		17	15.0	1	.00		86 / 86.0
5	31	8.57	1	0.02		26	12.0	1	0.02		21	15.0	1	0.00		85 / 85.0
6	38	10.0	2	.02		31	10.0	2	.00		25	15.0	1	.02		84 / 84.0
7	44	10.0	3	.00		37	12.0	2	.02		29	15.0	2	.00		83 / 83.0
8	50	10.0	3	.02		42	12.0	3	.02		33	12.0	2	.02		82 / 82.0
9	56	10.0	4	.02		47	12.0	4	.02		38	15.0	3	.02		81 / 81.0
10	1 2	8.57	5	0.03		52	12.0	5	0.02		42	15.0	4	0.00		80 / 80.0
11	9	10.0	7	.02		57	12.0	6	.02		46	15.0	4	.02		79 / 79.0
12	15	10.0	8	.02		1 2	12.0	7	.02		50	15.0	5	.02		78 / 78.0
13	21	10.0	9	.03		7	12.0	8	.02		54	15.0	6	.02		77 / 77.0
14	27	10.0	11	.02		12	10.0	9	.02		58	15.0	7	.02		76 / 76.1
15	33	10.0	12	0.03		18	12.0	10	0.03		1 2	15.0	8	0.02		75 / 75.1
16	39	10.0	14	.03		23	12.0	12	.02		6	15.0	9	.02		74 / 74.1
17	45	10.0	16	.03		28	12.0	13	.03		10	15.0	10	.03		73 / 73.1
18	51	10.0	18	.03		33	12.0	15	.02		14	15.0	12	.02		72 / 72.1
19	57	10.0	20	.03		38	12.0	16	.03		18	15.0	13	.02		71 / 71.1
20	2 3	10.0	22	0.03		43	12.0	18	0.03		22	15.0	14	0.03		70 / 70.1
21	9	10.0	24	.03		48	15.0	20	.03		26	15.0	16	.02		69 / 69.1
22	15	12.0	26	.03		52	12.0	22	.03		30	15.0	17	.03		68 / 68.1
23	20	10.0	28	.05		57	12.0	24	.03		34	15.0	19	.03		67 / 67.1
24	26	10.0	31	.05		2 2	12.0	26	.03		38	20.0	21	.02		66 / 66.1
25	32	10.0	34	0.03		7	15.0	28	0.03		41	15.0	22	0.03		65 / 65.1
26	38	12.0	36	.05		11	12.0	30	.05		45	15.0	24	.03		64 / 64.1
27	43	10.0	39	.05		16	12.0	33	.03		49	15.0	26	.03		63 / 63.1
28	49	12.0	42	.05		21	15.0	35	.03		53	20.0	28	.03		62 / 62.1
29	54	10.0	45	.05		25	12.0	37	.05		56	15.0	30	.03		61 / 61.1
30	3 0	12.0	48	0.05		30	12.0	40	0.05		2 0	15.0	32	0.03		60 / 60.1
31	5	10.0	51	.05		35	15.0	43	.03		4	20.0	34	.03		59 / 59.1
32	11	12.0	54	.07		39	15.0	45	.05		7	15.0	36	.05		58 / 58.1
33	16	12.0	58	.05		43	12.0	48	.05		11	20.0	39	.03		57 / 57.1
34	21	12.0	85 1	.07		48	15.0	51	.05		14	15.0	41	.03		56 / 56.1
35	26	12.0	5	0.05		52	15.0	54	0.05		18	20.0	43	0.05		55 / 55.1
36	31	12.0	8	.07		56	15.0	57	.05		21	20.0	46	.03		54 / 54.1
37	36	12.0	12	.07		3 0	12.0	86 0	.05		24	15.0	48	.05		53 / 53.1
38	41	12.0	16	.07		5	15.0	3	.07		28	20.0	51	.03		52 / 52.1
39	46	12.0	20	.07		9	15.0	7	.05		31	20.0	53	.05		51 / 51.1
40	51	12.0	24	0.07		13	15.0	10	0.05		34	20.0	56	0.05		50 / 50.1
41	56	12.0	28	.07		17	15.0	13	.07		37	15.0	59	.05		49 / 49.1
42	4 1	15.0	32	.07		21	15.0	17	.05		41	20.0	87 2	.03		48 / 48.1
43	5	12.0	36	.08		25	20.0	20	.07		44	20.0	4	.05		47 / 47.1
44	10	15.0	41	.07		28	15.0	24	.07		47	20.0	7	.05		46 / 46.1
45	14		45			32		28			50		10			45 / 45.1
t	a	60′/Δ	b	Δ/60′		a	60′/Δ	b	Δ/60′		a	60′/Δ	b	Δ/60′		a
	d = 84° 0′					d = 85° 0′					d = 86° 0′					

b / B	a = 84° 0′					a = 85° 0′					a = 86° 0′					c / C	a / β
	h \ d	60′/Δ		Z \ t	Δ/60′	h \ d	60′/Δ		Z \ t	Δ/60′	h \ d	60′/Δ		Z \ t	Δ/60′		
°	° ′			° ′		° ′			° ′		° ′			° ′		°	°
45	4 14	12.0		85 45	0.07	3 32	15.0		86 28	0.05	2 50	20.0		87 10	0.05	45	45.1
46	19	15.0		49	.08	36	20.0		31	.07	53	30.0		13	.05	44	44.1
47	23	15.0		54	.08	39	15.0		35	.07	55	20.0		16	.05	43	43.1
48	27	15.0		59	.07	43	20.0		39	.07	58	20.0		19	.05	42	42.1
49	31	15.0		86 3	.08	46	15.0		43	.07	3 1	20.0		22	.07	41	41.1
50	35	15.0		8	0.08	50	20.0		47	0.07	4	20.0		26	0.05	40	40.1
51	39	15.0		13	.08	53	20.0		51	.07	7	30.0		29	.05	39	39.1
52	43	15.0		18	.08	56	20.0		55	.07	9	20.0		32	.05	38	38.1
53	47	15.0		23	.08	59	20.0		59	.07	12	30.0		35	.07	37	37.1
54	51	15.0		28	.08	4 2	20.0		87 3	.08	14	20.0		39	.05	36	36.1
55	55	20.0		33	0.08	5	20.0		8	0.07	17	30.0		42	0.07	35	35.1
56	58	15.0		38	.08	8	20.0		12	.07	19	30.0		46	.05	34	34.1
57	5 2	20.0		43	.10	11	20.0		16	.08	21	20.0		49	.07	33	33.1
58	5	20.0		49	.08	14	20.0		21	.07	24	30.0		53	.05	32	32.1
59	8	20.0		54	.10	17	20.0		25	.08	26	30.0		56	.07	31	31.1
60	11	20.0		87 0	0.08	20	30.0		30	0.07	28	30.0		88 0	0.05	30	30.1
61	14	20.0		5	.10	22	20.0		34	.08	30	30.0		3	.07	29	29.1
62	17	20.0		11	.08	25	30.0		39	.08	32	30.0		7	.07	28	28.1
63	20	20.0		16	.10	27	20.0		44	.07	34	30.0		11	.07	27	27.1
64	23	20.0		22	.08	30	30.0		48	.08	36	30.0		15	.05	26	26.1
65	26	20.0		27	0.10	32	30.0		53	0.08	38	60.0		18	0.07	25	25.1
66	29	30.0		33	.10	34	30.0		58	.08	39	30.0		22	.07	24	24.1
67	31	20.0		39	.10	36	30.0		88 3	.07	41	60.0		26	.07	23	23.1
68	34	30.0		45	.10	38	30.0		7	.08	42	30.0		30	.07	22	22.1
69	36	30.0		51	.08	40	30.0		12	.08	44	30.0		34	.07	21	21.1
70	38	30.0		56	0.10	42	30.0		17	0.08	46	60.0		38	0.07	20	20.1
71	40	30.0		88 2	.10	44	60.0		22	.08	47	60.0		42	.07	19	19.1
72	42	30.0		8	.10	45	30.0		27	.08	48	30.0		46	.07	18	18.1
73	44	30.0		14	.10	47	30.0		32	.08	50	60.0		50	.07	17	17.1
74	46	30.0		20	.12	49	60.0		37	.08	51	60.0		54	.07	16	16.1
75	48	60.0		27	0.10	50	60.0		42	0.08	52	60.0		58	0.07	15	15.1
76	49	30.0		33	.10	51	60.0		47	.08	53	60.0		89 2	.07	14	14.1
77	51	60.0		39	.10	52	60.0		52	.08	54	60.0		6	.07	13	13.0
78	52	60.0		45	.10	53	60.0		57	.10	55	60.0		10	.07	12	12.0
79	53	60.0		51	.10	54	60.0		89 3	.08	56	—		14	.07	11	11.0
80	54	60.0		57	0.10	55	60.0		8	0.08	56	60.0		18	0.07	10	10.0
81	55	60.0		89 3	.12	56	60.0		13	.08	57	60.0		22	.08	9	9.0
82	56	60.0		10	.10	57	60.0		18	.08	58	—		27	.07	8	8.0
83	57	60.0		16	.10	58	—		23	.10	58	60.0		31	.07	7	7.0
84	58	60.0		22	.12	58	60.0		29	.08	59	—		35	.07	6	6.0
85	59	—		29	0.10	59	—		34	0.08	59	—		39	0.07	5	5.0
86	59	60.0		35	.10	59	60.0		39	.08	59	60.0		43	.07	4	4.0
87	6 0	—		41	.10	5 0	—		44	.10	4 0	—		47	.08	3	3.0
88	0	—		47	.12	0	—		50	.08	0	—		52	.07	2	2.0
89	0	—		54	.10	0	—		55	.08	0	—		56	.07	1	1.0
90	0			90 0		0			90 0		0			90 0		0	0.0
t	a	60′/Δ		b	Δ/60′	a	60′/Δ		b	Δ/60′	a	60′/Δ		b	Δ/60′		a
	d = 84° 0′					d = 85° 0′					d = 86° 0′						

0.052 0.035 0.020 0.017 0.000

b / B	a = 87° 0′			a = 88° 0′			a = 88° 50′			a = 89° 0′			a = 90° 0′			c / C
	h	d	Z	t	h	d	Z	t	h	d	Z	t	h	d	Z	t	
°	° ′		° ′		° ′		° ′		° ′		° ′		° ′		° ′		°
0	0 0		87 0		0 0		88 0		0 0		88 50		0 0		89 0		90
1		3		0		2		0		1		50		1		0	89
2		6		0		4		0		2		50		2		0	88
3		9		0		6		0		4		50		3		0	87
4		13		0		8		0		5		50		4		0	86
5		16		1		10		0		6		50		5		0	85
6		19		1		13		1		7		50		6		0	84
7		22		1		15		1		9		50		7		0	83
8		25		2		17		1		10		51		8		1	82
9		28		2		19		1		11		51		9		1	81
10		31		3		21		2		12		51		10		1	80
11		34		3		23		2		13		51		11		1	79
12		37		4		25		3		15		51		13		1	78
13		40		5		27		3		16		52		14		2	77
14		44		5		29		4		17		52		15		2	76
15		47		6		31		4		18		52		16		2	75
16		50		7		33		5		19		52		17		2	74
17		53		8		35		5		21		53		18		3	73
18		56		9		37		6		22		53		19		3	72
19		59		10		39		7		23		54		20		4	71
20	1	2		11		41		7		24		54		21		4	70
21		4		12		43		8		25		55		22		4	69
22		7		13		45		9		26		55		22		4	68
23		10		14		47		10		27		56		23		5	67
24		13		16		49		10		28		56		24		5	66
25		16		17		51		11		30		57		25		6	65
26		19		18		53		12		31		57		26		6	64
27		22		20		54		13		32		58		27		7	63
28		24		21		56		14		33		58		28		7	62
29		27		23		58		15		34		59		29		8	61
30		30		24	1	0		16		35		59		30		8	60
31		33		26		2		17		36	89	0		31		9	59
32		35		27		4		18		37		0		32		9	58
33		38		29		5		19		38		1		33		10	57
34		41		31		7		20		39		2		34		10	56
35		43		33		9		22		40		3		34		11	55
36		46		34		11		23		41		3		35		11	54
37		48		36		12		24		42		4		36		12	53
38		51		38		14		25		43		5		37		13	52
39		53		40		16		27		44		6		38		14	51
40		56		42		17		28		45		6		39		14	50
41		58		44		19		29		46		7		39		15	49
42	2	0		46		20		31		47		8		40		15	48
43		3		48		22		32		48		9		41		16	47
44		5		50		23		34		49		10		42		17	46
45		7		53		25		35		50		11		43		18	45

t	a	b	a	b	a	b	a	b	a	b
	d = 87° 0′		d = 88° 0′		d = 88° 50′ (*Polaris* in 1910)		d = 89° 0′		d = 90° 0′	

When *Polaris' t* < 90° : $L = (b + B) - 90°$.

	0.052		0.035		0.020		0.017		0.000		
b / B	a = 87° 0′		a = 88° 0′		a = 88° 50′		a = 89° 0′		a = 90° 0′		c / C
	h d	Z t	h d	Z t	h d	Z t	h d	Z t	h d	Z t	
°	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	°
45	2 7	87 53	1 25	88 35	0 50	89 11	0 43	89 18	0 0	90 0	**45**
46	9	55	26	37	50	11	43	18	0	0	44
47	12	57	28	38	51	12	44	19	0	0	43
48	14	59	29	40	52	13	45	20	0	0	42
49	16	88 2	31	41	53	14	45	21	0	0	41
50	18	4	32	43	54	15	46	21	0	0	**40**
51	20	7	33	44	54	16	46	22	0	0	39
52	22	9	35	46	55	17	47	23	0	0	38
53	24	12	36	48	56	18	48	24	0	0	37
54	26	14	37	49	57	19	49	25	0	0	36
55	27	17	38	51	57	20	49	26	0	0	**35**
56	29	19	39	53	58	21	50	26	0	0	34
57	31	22	41	55	59	22	50	27	0	0	33
58	33	25	42	56	1 0	23	51	28	0	0	32
59	34	27	43	58	0	24	51	29	0	0	31
60	36	30	44	89 0	1	25	52	30	0	0	**30**
61	37	33	45	2	1	26	52	31	0	0	29
62	39	35	46	4	2	27	53	32	0	0	28
63	40	38	47	5	2	28	53	33	0	0	27
64	42	41	48	7	3	29	54	34	0	0	26
65	43	44	49	9	3	30	54	35	0	0	**25**
66	44	47	50	11	4	32	55	36	0	0	24
67	46	50	50	13	4	33	55	37	0	0	23
68	47	53	51	15	5	34	56	38	0	0	22
69	48	55	52	17	5	35	56	38	0	0	21
70	49	58	53	19	6	36	56	39	0	0	**20**
71	50	89 1	53	21	6	37	56	40	0	0	19
72	51	4	54	23	7	38	57	41	0	0	18
73	52	7	55	25	7	40	57	42	0	0	17
74	53	10	55	27	8	41	58	43	0	0	16
75	54	13	56	29	8	42	58	44	0	0	**15**
76	55	16	56	31	8	43	58	45	0	0	14
77	55	19	57	33	8	44	58	46	0	0	13
78	56	23	57	35	9	45	59	47	0	0	12
79	57	26	58	37	9	47	59	49	0	0	11
80	57	29	58	39	9	48	59	50	0	0	**10**
81	58	32	59	41	9	49	59	51	0	0	9
82	58	35	59	43	9	50	59	52	0	0	8
83	59	38	59	45	10	51	1 0	53	0	0	7
84	59	41	59	47	10	53	0	54	0	0	6
85	59	44	2 0	50	10	54	0	55	0	0	**5**
86	3 0	47	0	52	10	55	0	56	0	0	4
87	0	51	0	54	10	56	0	57	0	0	3
88	0	54	0	56	10	58	0	58	0	0	2
89	0	57	0	58	10	59	0	59	0	0	1
90	0	90 0	0	90 0	10	90 0	0	90 0	0	0	**0**
t	a	b	a	b	a	b	a	b	a	b	
	d = 87° 0′		d = 88° 0′		d = 88° 50′ (*Polaris* in 1910)		d = 89° 0′		d = 90° 0′		

When *Polaris'* $t > 90°$: $L = (90° + B) - b$.

Change of Altitude per Minute of Arc of Hour Angle.

d and L same name $\begin{cases} t<90^\circ \begin{cases} L<b: \frac{\Delta h}{\Delta t} = -\,; \frac{\Delta_1 Z}{\Delta t} = - \\ L>b: \text{„} = -\,; \text{„} = + \end{cases} \\ t>90^\circ \quad \ldots: \text{„} = +\,; \text{„} = + \end{cases}$

d and L contrary names . . . . . : „ $= -$; „ $= +$

$$\frac{\Delta h}{\Delta t} = \mp \cos L \sin Z'$$

$$\frac{\Delta_1 Z}{\Delta t} = \mp \sin L$$

Z' \ L	0°	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	L / Z'
	sin Z'															
	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	
0°	0.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	0°
2	.03	.03	.03	.03	.03	.03	.03	.03	.03	.02	.02	.02	.02	.01	.01	2
4	.07	.07	.07	.07	.07	.06	.06	.06	.05	.05	.04	.04	.03	.03	.02	4
6	.10	.10	.10	.10	.10	.09	.09	.09	.08	.07	.07	.06	.05	.04	.04	6
8	.14	.14	.14	.13	.13	.13	.12	.11	.11	.10	.09	.08	.07	.06	.05	8
10	0.17	0.17	0.17	0.17	0.16	0.16	0.15	0.14	0.13	0.12	0.11	0.10	0.09	0.07	0.06	10
12	.21	.21	.20	.20	.20	.19	.18	.17	.16	.15	.13	.12	.10	.09	.07	12
14	.24	.24	.24	.23	.23	.22	.21	.20	.19	.17	.16	.14	.12	.10	.08	14
16	.28	.27	.27	.27	.26	.25	.24	.23	.21	.19	.18	.16	.14	.12	.09	16
18	.31	.31	.30	.30	.29	.28	.27	.25	.24	.22	.20	.18	.15	.13	.11	18
20	0.34	0.34	0.34	0.33	0.32	0.31	0.30	0.28	0.26	0.24	0.22	0.20	0.17	0.14	0.12	20
22	.37	.37	.37	.36	.35	.34	.32	.31	.29	.27	.24	.21	.19	.16	.13	22
24	.41	.41	.40	.39	.38	.37	.35	.33	.31	.29	.26	.23	.20	.17	.14	24
26	.44	.44	.43	.42	.41	.40	.38	.36	.34	.31	.28	.25	.22	.19	.15	26
28	.47	.47	.46	.45	.44	.43	.41	.38	.36	.33	.30	.27	.23	.20	.16	28
30	0.50	0.50	0.49	0.48	0.47	0.45	0.43	0.41	0.38	0.35	0.32	0.29	0.25	0.21	0.17	30
32	.53	.53	.52	.51	.50	.48	.46	.43	.41	.37	.34	.30	.27	.22	.18	32
34	.56	.56	.55	.54	.53	.51	.48	.46	.43	.40	.36	.32	.28	.24	.19	34
36	.59	.59	.58	.57	.55	.53	.51	.48	.45	.42	.38	.34	.29	.25	.20	36
38	.62	.61	.61	.59	.58	.56	.53	.50	.47	.44	.40	.35	.31	.26	.21	38
40	0.64	0.64	0.63	0.62	0.60	0.58	0.56	0.53	0.49	0.45	0.41	0.37	0.32	0.27	0.22	40
42	.67	.67	.66	.65	.63	.61	.58	.55	.51	.47	.43	.38	.33	.28	.23	42
44	.69	.69	.68	.67	.65	.63	.60	.57	.53	.49	.45	.40	.35	.29	.24	44
46	.72	.72	.71	.69	.68	.65	.62	.59	.55	.51	.46	.41	.36	.30	.25	46
48	.74	.74	.73	.72	.70	.67	.64	.61	.57	.53	.48	.43	.37	.31	.25	48
50	0.77	0.76	0.75	0.74	0.72	0.69	0.66	0.63	0.59	0.54	0.49	0.44	0.38	0.32	0.26	50
52	.79	.78	.78	.76	.74	.71	.68	.65	.60	.56	.51	.45	.39	.33	.27	52
54	.81	.81	.80	.78	.76	.73	.70	.66	.62	.57	.52	.46	.40	.34	.28	54
56	.83	.83	.82	.80	.78	.75	.72	.68	.64	.59	.53	.48	.41	.35	.28	56
58	.85	.84	.83	.82	.80	.77	.73	.69	.65	.60	.55	.49	.42	.36	.29	58
60	0.87	0.86	0.85	0.84	0.81	0.78	0.75	0.71	0.66	0.61	0.56	0.50	0.43	0.37	0.30	60
62	.88	.88	.87	.85	.83	.80	.76	.72	.68	.62	.57	.51	.44	.37	.30	62
64	.90	.90	.89	.87	.84	.81	.78	.74	.69	.64	.58	.52	.45	.38	.31	64
66	.91	.91	.90	.88	.86	.83	.79	.75	.70	.65	.59	.52	.46	.39	.31	66
68	.93	.92	.91	.90	.87	.84	.80	.76	.71	.66	.60	.53	.46	.39	.32	68
70	0.94	0.94	0.93	0.91	0.88	0.85	0.81	0.77	0.72	0.66	0.60	0.54	0.47	0.40	0.32	70
72	.95	.95	.94	.92	.89	.86	.82	.78	.73	.67	.61	.55	.48	.40	.33	72
74	.96	.96	.95	.93	.90	.87	.83	.79	.74	.68	.62	.55	.48	.41	.33	74
76	.97	.97	.96	.94	.91	.88	.84	.79	.74	.69	.62	.56	.49	.41	.33	76
78	.98	.97	.96	.94	.92	.89	.85	.80	.75	.69	.63	.56	.49	.41	.33	78
80	0.98	0.98	0.97	0.95	0.93	0.89	0.85	0.81	0.75	0.70	0.63	0.56	0.49	0.42	0.34	80
82	.99	.99	.98	.96	.93	.90	.86	.81	.76	.70	.64	.57	.50	.42	.34	82
84	.99	.99	.98	.96	.93	.90	.86	.81	.76	.70	.64	.57	.50	.42	.34	84
86	1.00	.99	.98	.96	.94	.90	.86	.82	.76	.71	.64	.57	.50	.42	.34	86
88	1.00	1.00	.98	.97	.94	.91	.87	.82	.77	.71	.64	.57	.50	.42	.34	88
90	1.00	1.00	0.98	0.97	0.94	0.91	0.87	0.82	0.77	0.71	0.64	0.57	0.50	0.42	0.34	90

To find $\frac{\Delta_1 Z}{\Delta t}$ or sin L, enter column $L=0°$ with L instead of Z'.

Change of Hour Angle per Minute of Arc of Altitude

$$\frac{\Delta t}{\Delta h} = \sec L \operatorname{cosec} Z$$

L \ Z	60°	62°	64°	66°	68°	70°	72°	74°	76°	78°	80°	82°	84°	87°	90°	Z \ L
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	1.15	1.13	1.11	1.09	1.08	1.06	1.05	1.04	1.03	1.02	1.02	1.01	1.01	1.00	1.00	0
2	1.16	1.13	1.11	1.09	1.08	1.06	1.05	1.04	1.03	1.02	1.02	1.01	1.01	1.00	1.00	2
4	1.16	1.14	1.12	1.10	1.08	1.07	1.05	1.04	1.03	1.02	1.02	1.01	1.01	1.00	1.00	4
6	1.16	1.14	1.12	1.10	1.08	1.07	1.06	1.05	1.04	1.03	1.02	1.01	1.01	1.01	1.01	6
8	1.17	1.14	1.12	1.10	1.09	1.08	1.06	1.05	1.04	1.03	1.03	1.02	1.02	1.01	1.01	8
10	1.17	1.15	1.13	1.11	1.10	1.08	1.07	1.06	1.05	1.04	1.03	1.02	1.02	1.02	1.02	10
11	1.18	1.15	1.13	1.11	1.10	1.08	1.07	1.06	1.05	1.04	1.03	1.03	1.03	1.02	1.02	11
12	1.18	1.16	1.14	1.12	1.10	1.09	1.08	1.06	1.05	1.04	1.04	1.03	1.03	1.02	1.02	12
13	1.19	1.16	1.14	1.12	1.11	1.09	1.08	1.07	1.06	1.05	1.04	1.04	1.03	1.03	1.03	13
14	1.19	1.17	1.15	1.13	1.11	1.10	1.08	1.07	1.06	1.05	1.05	1.04	1.04	1.03	1.03	14
15	1.20	1.17	1.15	1.13	1.12	1.10	1.09	1.08	1.07	1.06	1.05	1.05	1.04	1.04	1.04	15
16	1.20	1.18	1.16	1.14	1.12	1.11	1.09	1.08	1.07	1.06	1.06	1.05	1.05	1.04	1.04	16
17	1.21	1.18	1.16	1.14	1.13	1.11	1.10	1.09	1.08	1.07	1.06	1.06	1.05	1.05	1.05	17
18	1.21	1.19	1.17	1.15	1.13	1.12	1.11	1.09	1.08	1.07	1.07	1.06	1.06	1.05	1.05	18
19	1.22	1.20	1.18	1.16	1.14	1.13	1.11	1.10	1.09	1.08	1.07	1.07	1.06	1.06	1.06	19
20	1.23	1.21	1.18	1.16	1.15	1.13	1.12	1.11	1.10	1.09	1.08	1.08	1.07	1.07	1.06	20
21	1.24	1.21	1.19	1.17	1.16	1.14	1.13	1.11	1.10	1.09	1.09	1.08	1.08	1.07	1.07	21
22	1.24	1.22	1.20	1.18	1.16	1.15	1.13	1.12	1.11	1.10	1.10	1.09	1.08	1.08	1.08	22
23	1.25	1.23	1.21	1.19	1.17	1.16	1.14	1.13	1.12	1.11	1.10	1.10	1.09	1.09	1.09	23
24	1.26	1.24	1.22	1.20	1.18	1.17	1.15	1.14	1.13	1.12	1.11	1.11	1.10	1.10	1.09	24
25	1.27	1.25	1.23	1.21	1.19	1.17	1.16	1.15	1.14	1.13	1.12	1.11	1.11	1.10	1.10	25
26	1.28	1.26	1.24	1.22	1.20	1.18	1.17	1.16	1.15	1.14	1.13	1.12	1.12	1.11	1.11	26
27	1.30	1.27	1.25	1.23	1.21	1.19	1.18	1.17	1.16	1.15	1.14	1.13	1.13	1.12	1.12	27
28	1.31	1.28	1.26	1.24	1.22	1.20	1.19	1.18	1.17	1.16	1.15	1.14	1.14	1.13	1.13	28
29	1.32	1.30	1.27	1.25	1.23	1.22	1.20	1.19	1.18	1.17	1.16	1.15	1.15	1.14	1.14	29
30	1.33	1.31	1.28	1.26	1.24	1.23	1.21	1.20	1.19	1.18	1.17	1.17	1.16	1.16	1.15	30
31	1.35	1.32	1.30	1.28	1.26	1.24	1.23	1.21	1.20	1.19	1.18	1.18	1.17	1.17	1.17	31
32	1.36	1.34	1.31	1.29	1.27	1.26	1.24	1.23	1.22	1.21	1.20	1.19	1.19	1.18	1.18	32
33	1.38	1.35	1.33	1.31	1.29	1.27	1.25	1.24	1.23	1.22	1.21	1.20	1.20	1.19	1.19	33
34	1.39	1.37	1.34	1.32	1.30	1.28	1.27	1.26	1.24	1.23	1.22	1.22	1.21	1.21	1.21	34
35	1.41	1.38	1.36	1.34	1.32	1.30	1.28	1.27	1.26	1.25	1.24	1.23	1.23	1.22	1.22	35
36	1.43	1.40	1.38	1.35	1.33	1.31	1.30	1.29	1.27	1.26	1.25	1.25	1.24	1.24	1.24	36
37	1.45	1.42	1.39	1.37	1.35	1.33	1.32	1.30	1.29	1.28	1.27	1.26	1.26	1.25	1.25	37
38	1.47	1.44	1.41	1.39	1.37	1.35	1.33	1.32	1.31	1.30	1.29	1.28	1.28	1.27	1.27	38
39	1.49	1.46	1.43	1.41	1.39	1.37	1.35	1.34	1.33	1.32	1.31	1.30	1.29	1.29	1.29	39
40	1.51	1.48	1.45	1.43	1.41	1.39	1.37	1.36	1.35	1.34	1.33	1.32	1.31	1.31	1.31	40
41	1.53	1.50	1.47	1.45	1.43	1.41	1.39	1.38	1.37	1.36	1.35	1.34	1.33	1.33	1.32	41
42	1.55	1.52	1.50	1.47	1.45	1.43	1.41	1.40	1.39	1.38	1.37	1.36	1.35	1.35	1.35	42
43	1.58	1.55	1.52	1.50	1.48	1.46	1.44	1.42	1.41	1.40	1.39	1.38	1.37	1.37	1.37	43
44	1.60	1.57	1.55	1.52	1.50	1.48	1.46	1.45	1.43	1.42	1.41	1.40	1.40	1.39	1.39	44
45	1.63	1.60	1.57	1.55	1.53	1.51	1.49	1.47	1.46	1.45	1.44	1.43	1.42	1.42	1.41	45
46	1.66	1.63	1.60	1.58	1.55	1.53	1.51	1.50	1.48	1.47	1.46	1.45	1.45	1.44	1.44	46
47	1.69	1.66	1.63	1.61	1.58	1.56	1.54	1.53	1.51	1.50	1.49	1.48	1.47	1.47	1.47	47
48	1.73	1.69	1.66	1.64	1.61	1.59	1.57	1.56	1.54	1.53	1.52	1.51	1.50	1.50	1.49	48
49	1.76	1.73	1.70	1.67	1.64	1.62	1.60	1.59	1.57	1.56	1.55	1.54	1.53	1.53	1.52	49
50	1.80	1.76	1.73	1.70	1.68	1.66	1.64	1.62	1.60	1.59	1.58	1.57	1.56	1.56	1.56	50
51	1.84	1.80	1.77	1.74	1.71	1.69	1.67	1.65	1.64	1.63	1.61	1.60	1.60	1.59	1.59	51
52	1.88	1.84	1.81	1.78	1.75	1.73	1.71	1.69	1.67	1.66	1.65	1.64	1.63	1.63	1.62	52
53	1.92	1.88	1.85	1.82	1.79	1.77	1.75	1.73	1.71	1.70	1.69	1.68	1.67	1.66	1.66	53
54	1.96	1.93	1.89	1.86	1.83	1.81	1.79	1.77	1.75	1.74	1.73	1.72	1.71	1.70	1.70	54
55	2.01	1.98	1.94	1.91	1.88	1.85	1.83	1.81	1.80	1.78	1.77	1.76	1.75	1.75	1.74	55
56	2.06	2.03	1.99	1.96	1.93	1.90	1.88	1.86	1.84	1.83	1.82	1.81	1.80	1.79	1.79	56
57	2.12	2.08	2.04	2.01	1.98	1.95	1.93	1.91	1.89	1.88	1.86	1.85	1.85	1.84	1.84	57
58	2.18	2.14	2.10	2.07	2.04	2.01	1.98	1.96	1.94	1.93	1.92	1.91	1.90	1.89	1.89	58
59	2.24	2.20	2.16	2.13	2.10	2.07	2.04	2.02	2.00	1.99	1.97	1.96	1.95	1.94	1.94	59
60	2.31	2.27	2.23	2.19	2.16	2.13	2.10	2.08	2.06	2.05	2.03	2.02	2.01	2.00	2.00	60

Change of Azimuth per Minute of Arc of Altitude.

$$\frac{\Delta_2 Z}{\Delta h} = -\tan h' \cot Z' \ (-\textit{always} \text{ with } Z' \text{ less than } 90°).$$

Z' / h'	0°	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	60°	70°	80°	90°	Z'
		′	′	′	′	′	′	′	′	′	′	′	′	′	′	
0°	*ind.*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	90°
2	∞	.40	.20	.13	.10	.07	.06	.05	.04	.03	.03	.02	.01	.01	.00	88
4	∞	.80	.40	.26	.19	.15	.12	.10	.08	.07	.06	.04	.03	.01	.00	86
6	∞	1.20	.60	.39	.29	.23	.18	.15	.13	.11	.09	.06	.04	.02	.00	84
8	∞	1.61	.80	.52	.39	.30	.24	.20	.17	.14	.12	.08	.05	.02	.00	82
10	∞	2.02	1.00	0.66	0.48	0.38	0.31	0.25	0.21	0.18	0.15	0.10	0.06	0.03	0.00	80
12	∞	2.43	1.21	.79	.58	.46	.37	.30	.25	.21	.18	.12	.08	.04	.00	78
14	∞	2.85	1.41	.93	.69	.53	.43	.36	.30	.25	.21	.14	.09	.04	.00	76
16	∞	3.28	1.63	1.07	.79	.61	.50	.41	.34	.29	.24	.17	.10	.05	.00	74
18	∞	3.71	1.84	1.21	.89	.70	.56	.46	.39	.32	.27	.19	.12	.06	.00	72
20	∞	4.16	2.06	1.36	1.00	0.78	0.63	0.52	0.43	0.36	0.31	0.21	0.13	0.06	0.00	70
22	∞	4.62	2.29	1.51	1.11	.87	.70	.58	.48	.40	.34	.23	.15	.07	.00	68
24	∞	5.09	2.53	1.66	1.22	.95	.77	.64	.53	.45	.37	.26	.16	.08	.00	66
26	∞	5.57	2.77	1.82	1.34	1.05	.84	.70	.58	.49	.41	.28	.18	.09	.00	64
28	∞	6.08	3.02	1.98	1.46	1.14	.92	.76	.63	.53	.45	.31	.19	.09	.00	62
30	∞	6.60	3.27	2.15	1.59	1.24	1.00	0.82	0.69	0.58	0.48	0.33	0.21	0.10	0.00	60
32	∞	7.14	3.54	2.33	1.72	1.34	1.08	.89	.74	.62	.52	.36	.23	.11	.00	58
34	∞	7.71	3.83	2.52	1.85	1.45	1.17	.96	.80	.67	.57	.39	.25	.12	.00	56
36	∞	8.30	4.12	2.71	2.00	1.56	1.26	1.04	.87	.73	.61	.42	.26	.13	.00	54
38	∞	8.93	4.43	2.92	2.15	1.68	1.35	1.12	.93	.78	.66	.45	.28	.14	.00	52
40	∞	9.59	4.76	3.13	2.31	1.80	1.45	1.20	1.00	0.84	0.70	0.48	0.31	0.15	0.00	50
42	∞	10.29	5.11	3.36	2.47	1.93	1.56	1.29	1.07	.90	.76	.52	.33	.16	.00	48
44	∞	11.04	5.48	3.60	2.65	2.07	1.67	1.38	1.15	.97	.81	.56	.35	.17	.00	46
46	∞	11.84	5.87	3.86	2.85	2.22	1.79	1.48	1.23	1.04	.87	.60	.38	.18	.00	44
48	∞	12.69	6.30	4.14	3.05	2.38	1.92	1.59	1.32	1.11	.93	.64	.40	.20	.00	42
50	∞	13.62	6.76	4.45	3.27	2.56	2.06	1.70	1.42	1.19	1.00	0.69	0.43	0.21	0.00	40
52	∞	14.63	7.26	4.78	3.52	2.74	2.22	1.83	1.53	1.28	1.07	.74	.47	.23	.00	38
54	∞	15.73	7.81	5.14	3.78	2.95	2.38	1.97	1.64	1.38	1.15	.80	.50	.24	.00	36
56	∞	16.95	8.41	5.53	4.07	3.18	2.57	2.12	1.77	1.48	1.24	.86	.54	.26	.00	34
58	∞	18.29	9.08	5.97	4.40	3.43	2.77	2.29	1.91	1.60	1.34	.92	.58	.28	.00	32
60	∞	19.80	9.82	6.46	4.76	3.71	3.00	2.47	2.06	1.73	1.45	1.00	0.63	0.31	0.00	30
62	∞	21.50	10.67	7.02	5.17	4.03	3.26	2.69	2.24	1.88	1.58	1.09	.68	.33	.00	28
64	∞	23.44	11.63	7.65	5.63	4.40	3.55	2.93	2.44	2.05	1.72	1.19	.75	.36	.00	26
66	∞	25.67	12.74	8.38	6.17	4.82	3.89	3.21	2.68	2.25	1.88	1.30	.82	.40	.00	24
68	∞	28.29	14.04	9.24	6.80	5.31	4.29	3.53	2.95	2.48	2.08	1.43	.90	.44	.00	22
70	∞	31.40	15.58	10.25	7.55	5.89	4.76	3.92	3.27	2.75	2.31	1.59	1.00	0.48	0.00	20
72	∞	35.18	17.45	11.49	8.46	6.60	5.33	4.40	3.67	3.08	2.58	1.78	1.12	.54	.00	18
74	∞	39.86	19.78	13.01	9.58	7.48	6.04	4.98	4.16	3.49	2.93	2.01	1.27	.61	.00	16
76	∞	45.84	22.75	14.97	11.02	8.60	6.95	5.73	4.78	4.01	3.37	2.32	1.46	.71	.00	14
78	∞	53.77	26.68	17.56	12.93	10.09	8.15	6.72	5.61	4.70	3.95	2.72	1.71	.83	.00	12
80	∞	64.82	32.16	21.17	15.58	12.16	9.82	8.10	6.76	5.67	4.76	3.27	2.06	1.00	0.00	10
82	∞	86.68	40.35	26.56	19.55	15.26	12.32	10.16	8.48	7.12	5.97	4.11	2.59	1.25	.00	8
84	∞	—	53.96	35.51	26.14	20.40	16.48	13.59	11.34	9.51	7.98	5.49	3.46	1.68	.00	6
86	∞	—	81.10	53.37	39.29	30.67	24.77	20.42	17.04	14.30	12.00	8.26	5.21	2.52	.00	4
88	∞	—	—	—	78.68	61.41	49.60	40.90	34.13	28.64	24.03	16.53	10.42	5.05	.00	2
90	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	*ind.*	0
h'	90°	85°	80°	75°	70°	65°	60°	55°	50°	45°	40°	30°	20°	10°	0°	Z' / h'

Table for Controlling the Coincidence of Lines of Position.

Giving D ($\frac{1}{2}$ of the useful length of the line of position) in minutes of the Equator.

d or t	True Altitude of Celestial Body.														t
	0°	10°	20°	30°	40°	50°	55°	60°	65°	70°	75°	80°	83°	86°	89°	
	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	
0°	83	82	80	77	73	67	63	59	54	49	42	35	29	22	11	180°
10	84	83	81	78	73	67	63	59	54	49	43	35	29	22	11	170
20	86	85	83	80	75	69	65	61	56	50	44	36	30	23	11	160
30	89	88	86	83	78	71	67	63	58	52	45	37	31	24	12	150
40	95	94	92	88	83	76	72	67	62	55	48	39	33	25	13	140
50	103	103	100	96	91	83	78	73	67	60	53	43	36	27	14	130
60	117	116	114	109	103	94	89	83	76	67	60	49	41	31	15	120
70	142	141	137	132	124	114	107	100	92	83	72	59	49	37	19	110
80	199	198	193	185	174	159	151	141	129	116	101	83	69	53	26	100
90	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	90

To find D ($\frac{1}{2}$ of the useful length of the line of position on Mercator's chart: BB_3 in Fig. 3) enter the table with the declination in column d and corresponding to the altitude h will be found D_0 ($\frac{1}{2}$ of the useful length if t was 0°). Entering the table again with D_0 in the first horizontal line corresponding to d=0° and with t in column t we will find crossing the value of D, expressed in minutes of longitude.

Ex. d=50°, h=60° and t=40°. First we would find D_0=73′ and afterwards D=83′.

Azimuths of *Polaris*.

Local Sidereal Time	Name.	Latitude.											Name.	Local Sidereal Time.
		0°	10°	20°	30°	40°	45°	50°	55°	60°	65°	70°		
		°	°	°	°	°	°	°	°	°	°	°		
0h	E	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.8	0.9	1.0	1.2	W	12h
1	E	.1	.1	.1	.2	.2	.2	.2	.2	.3	.3	.3	W	13
2	W	.2	.2	.2	.2	.2	.2	.3	.3	.3	.4	.6	E	14
3	W	.5	.5	.5	.5	.6	.6	.7	.8	.9	1.1	1.5	E	15
4	W	.7	.7	.8	.8	.9	1.0	1.1	1.3	1.4	1.7	2.1	E	16
5	W	.9	.9	1.0	1.1	1.2	1.3	1.5	1.7	1.9	2.2	2.7	E	17
6	W	1.1	1.1	1.2	1.3	1.4	1.5	1.7	1.9	2.2	2.6	3.2	E	18
7	W	1.2	1.2	1.2	1.3	1.5	1.6	1.8	2.0	2.3	2.7	3.4	E	19
8	W	1.2	1.2	1.2	1.3	1.5	1.6	1.8	2.0	2.3	2.7	3.4	E	20
9	W	1.1	1.1	1.1	1.2	1.4	1.5	1.7	1.9	2.1	2.5	3.2	E	21
10	W	.9	.9	1.0	1.1	1.2	1.3	1.4	1.6	1.8	2.2	2.7	E	22
11	W	.7	.7	.7	.8	.9	1.0	1.1	1.2	1.4	1.7	2.1	E	23

This table will be very useful for finding the deviation of the compass in the northern hemisphere. It was computed assuming the Star's Right Ascension 1h 27m and its Declination 88° 50′ N. by the following formula: $Z \cos L = p \sin t$, where p represents the Star's Polar Distance=70′, the other terms being negligible within the limits of the table.

Change of Altitude per Minute of Time.

Lat.	Azimuth.																
	0°	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	90°
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
0	0	1.3	2.6	3.9	5.1	6.3	7.5	8.6	9.6	10.6	11.5	12.3	13.0	13.6	14.1	14.5	14.8	15.0
4	0	1.3	2.6	3.9	5.1	6.3	7.5	8.6	9.6	10.6	11.5	12.3	13.0	13.6	14.1	14.5	14.7	15.0
8	0	1.3	2.6	3.8	5.1	6.3	7.4	8.5	9.5	10.5	11.4	12.2	12.9	13.5	14.0	14.4	14.6	14.9
12	0	1.3	2.5	3.8	5.0	6.2	7.3	8.4	9.4	10.4	11.2	12.0	12.7	13.3	13.8	14.2	14.4	14.7
16	0	1.3	2.5	3.7	4.9	6.1	7.2	8.3	9.3	10.2	11.0	11.8	12.5	13.1	13.5	13.9	14.2	14.4
20	0	1.2	2.4	3.6	4.8	6.0	7.0	8.1	9.1	10.0	10.8	11.5	12.2	12.8	13.2	13.6	13.9	14.1
24	0	1.2	2.4	3.5	4.7	5.8	6.9	7.9	8.8	9.7	10.5	11.2	11.9	12.4	12.9	13.2	13.5	13.7
26	0	1.2	2.3	3.5	4.6	5.7	6.7	7.7	8.7	9.5	10.3	11.0	11.7	12.2	12.7	13.0	13.3	13.5
28	0	1.2	2.3	3.4	4.5	5.6	6.6	7.6	8.5	9.4	10.1	10.8	11.5	12.0	12.4	12.8	13.1	13.2
30	0	1.1	2.3	3.4	4.4	5.5	6.5	7.4	8.3	9.2	9.9	10.6	11.2	11.8	12.2	12.5	12.8	13.0
32	0	1.1	2.2	3.3	4.4	5.4	6.4	7.3	8.2	9.0	9.7	10.4	11.0	11.5	12.0	12.3	12.5	12.7
34	0	1.1	2.2	3.2	4.3	5.3	6.2	7.1	8.0	8.8	9.5	10.2	10.8	11.3	11.7	12.0	12.3	12.4
36	0	1.1	2.1	3.1	4.2	5.1	6.1	7.0	7.8	8.6	9.3	9.9	10.5	11.0	11.4	11.7	12.0	12.1
38	0	1.0	2.1	3.1	4.0	5.0	5.9	6.8	7.6	8.4	9.1	9.7	10.2	10.7	11.1	11.4	11.6	11.8
40	0	1.0	2.0	3.0	3.9	4.9	5.7	6.6	7.4	8.1	8.8	9.4	10.0	10.4	10.8	11.1	11.3	11.5
42	0	1.0	1.9	2.9	3.8	4.7	5.6	6.4	7.2	7.9	8.5	9.1	9.7	10.1	10.5	10.8	11.0	11.1
44	0	.9	1.9	2.8	3.7	4.6	5.4	6.2	6.9	7.6	8.3	8.8	9.3	9.8	10.1	10.4	10.6	10.8
46	0	.9	1.8	2.7	3.6	4.4	5.2	6.0	6.7	7.4	8.0	8.5	9.0	9.4	9.8	10.1	10.3	10.4
48	0	.9	1.7	2.6	3.4	4.3	5.0	5.8	6.5	7.1	7.7	8.2	8.7	9.1	9.4	9.7	9.9	10.0
50	0	.8	1.7	2.5	3.3	4.1	4.8	5.5	6.2	6.8	7.4	7.9	8.3	8.7	9.1	9.3	9.5	9.6
52	0	.8	1.6	2.4	3.2	3.9	4.6	5.3	5.9	6.5	7.1	7.6	8.0	8.4	8.7	8.9	9.1	9.2
54	0	.8	1.5	2.3	3.0	3.7	4.4	5.1	5.7	6.2	6.8	7.2	7.6	8.0	8.3	8.5	8.7	8.8
56	0	.7	1.5	2.2	2.9	3.5	4.2	4.8	5.4	5.9	6.4	6.9	7.3	7.6	7.9	8.1	8.3	8.4
58	0	.7	1.4	2.1	2.7	3.4	4.0	4.6	5.1	5.6	6.1	6.5	6.9	7.2	7.5	7.7	7.8	7.9
60	0	.7	1.3	1.9	2.6	3.2	3.8	4.3	4.8	5.3	5.7	6.1	6.5	6.8	7.0	7.2	7.4	7.5
62	0	.6	1.2	1.8	2.4	3.0	3.5	4.0	4.5	5.0	5.4	5.8	6.1	6.4	6.6	6.8	6.9	7.0
64	0	.6	1.1	1.7	2.2	2.8	3.3	3.8	4.2	4.6	5.0	5.4	5.7	6.0	6.2	6.4	6.5	6.6
66	0	.5	1.1	1.6	2.1	2.6	3.1	3.5	3.9	4.3	4.7	5.0	5.3	5.5	5.7	5.9	6.0	6.1
68	0	.5	1.0	1.5	1.9	2.4	2.8	3.2	3.6	4.0	4.3	4.6	4.9	5.1	5.3	5.4	5.6	5.6
70	0	.4	.9	1.3	1.8	2.2	2.6	2.9	3.3	3.6	3.9	4.2	4.4	4.6	4.8	5.0	5.1	5.1

Table for Rectifying Lines of Position.

h	D=30′		D=36′		D=42′		D=48′		D=54′		D=60′		h
	Δh	Z_1	Δh	Z_1	Δh	Z_1	Δh	Z_1	Δh	Z_1	Δh	Z_1	
°	′	°	′	°	′	°	′	°	′	°	′	°	°
20	0.0	89.8	0.1	89.8	0.1	89.7	0.1	89.7	0.2	89.7	0.2	89.6	20
30	.1	89.7	.1	89.7	.1	89.6	.2	89.5	.2	89.5	.3	89.4	30
40	.1	89.6	.2	89.5	.2	89.4	.3	89.3	.4	89.2	.4	89.2	40
45	0.1	89.5	0.2	89.4	0.3	89.3	0.3	89.2	0.4	89.1	0.5	89.0	45
50	.2	89.4	.2	89.3	.3	89.2	.4	89.0	.5	88.9	.6	88.8	50
55	.2	89.3	.3	89.1	.4	89.0	.5	88.9	.6	88.7	.7	88.6	55
60	0.2	89.1	0.3	89.0	0.4	88.8	0.6	88.6	0.7	88.4	0.9	88.3	60
61	.2	89.1	.3	88.9	.5	88.7	.6	88.6	.8	88.4	.9	88.2	61
62	.2	89.1	.4	88.9	.5	88.7	.6	88.5	.8	88.3	1.0	88.1	62
63	.3	89.0	.4	88.8	.5	88.6	.7	88.4	.8	88.2	1.0	88.0	63
64	.3	89.0	.4	88.8	.5	88.6	.7	88.4	.9	88.2	1.1	88.0	64
65	0.3	88.9	0.4	88.7	0.6	88.5	0.7	88.3	0.9	88.1	1.1	87.9	65
66	.3	88.9	.4	88.7	.6	88.4	.8	88.2	1.0	88.0	1.2	87.8	66
67	.3	88.8	.4	88.6	.6	88.4	.8	88.1	1.0	87.9	1.2	87.6	67
68	.3	88.8	.5	88.5	.6	88.3	.8	88.0	1.0	87.8	1.3	87.5	68
69	.3	88.7	.5	88.4	.7	88.2	.9	87.9	1.1	87.7	1.4	87.4	69
70	0.4	88.6	0.5	88.4	0.7	88.1	0.9	87.8	1.2	87.5	1.4	87.3	70
71	.4	88.5	.5	88.3	.7	88.0	1.0	87.7	1.2	87.4	1.5	87.1	71
72	.4	88.5	.6	88.2	.8	87.8	1.0	87.5	1.3	87.2	1.6	86.9	72
73	.4	88.4	.6	88.0	.8	87.7	1.1	87.4	1.4	87.1	1.7	86.7	73
74	.5	88.3	.7	87.9	.9	87.6	1.2	87.2	1.5	86.9	1.8	86.5	74
75	0.5	88.1	0.7	87.8	1.0	87.4	1.3	87.0	1.6	86.6	2.0	86.3	75

Table for Rectifying Lines of Position

h	D=6′		D=10′		D=14′		D=18′		D=22′		D=26′		D=30′		h
	Δh	Z_1	Δh	Z_1	Δh	Z_1	Δh	Z_1	Δh	Z_1	Δh	Z_1	Δh	Z_1	
° ′	′	°	′	°	′	°	′	°	′	°	′	°	′	°	° ′
75 0	0.0	89.6	0.1	89.4	0.1	89.1	0.2	88.9	0.3	88.6	0.4	88.4	0.5	88.1	75 0
76 0	.0	89.6	.1	89.3	.1	89.1	.2	88.8	.3	88.5	.4	88.3	.5	88.0	76 0
77 0	.0	89.6	.1	89.3	.1	89.0	.2	88.7	.3	88.4	.4	88.1	.6	87.8	77 0
78 0	.0	89.5	.1	89.2	.1	88.9	.2	88.6	.3	88.3	.5	88.0	.6	87.6	78 0
79 0	.0	89.5	.1	89.1	.1	88.8	.2	88.5	.4	88.1	.5	87.8	.7	87.4	79 0
80 0	0.0	89.5	0.1	89.0	0.2	88.7	0.3	88.3	0.4	87.9	0.6	87.5	0.7	87.1	80 0
81 0	.0	89.4	.1	88.9	.2	88.5	.3	88.1	.4	87.7	.6	87.2	.8	86.8	81 0
82 0	.0	89.3	.1	88.8	.2	88.3	.3	87.9	.5	87.4	.7	86.9	.9	86.4	82 0
83 0	.0	89.2	.1	88.6	.2	88.1	.4	87.5	.6	87.0	.8	86.5	1.1	85.9	83 0
84 0	.0	89.0	.1	88.4	.3	87.8	.5	87.1	.7	86.5	.9	85.9	1.2	85.2	84 0
30	.1	89.0	.1	88.3	.3	87.6	.5	86.9	.7	86.2	1.0	85.5	1.4	84.8	30
85 0	0.1	88.9	0.2	88.1	0.3	87.3	0.5	86.6	0.8	85.8	1.1	85.0	1.5	84.3	85 0
20	.1	88.8	.2	88.0	.3	87.1	.6	86.3	.9	85.5	1.2	84.7	1.6	83.9	20
40	.1	88.7	.2	87.8	.4	86.9	.6	86.0	.9	85.2	1.3	84.3	1.7	83.4	40
86 0	.1	88.6	.2	87.6	.4	86.7	.7	85.7	1.0	84.8	1.4	83.8	1.9	82.9	86 0
20	.1	88.4	.2	87.4	.4	86.4	.7	85.3	1.1	84.3	1.5	83.3	2.0	82.2	20
40	.1	88.3	.2	87.1	.5	86.0	.8	84.9	1.2	83.7	1.7	82.6	2.2	81.5	40
87 0	0.1	88.1	0.3	86.8	0.5	85.6	0.9	84.3	1.3	83.0	1.9	81.8	2.5	80.5	87 0
10	.1	88.0	.3	86.7	.6	85.3	.9	84.0	1.4	82.6	2.0	81.3	2.6	80.0	10
20	.1	87.9	.3	86.4	.6	85.0	1.0	83.6	1.5	82.2	2.1	80.8	2.8	79.4	20
30	.1	87.7	.3	86.2	.7	84.7	1.1	83.2	1.6	81.7	2.2	80.2	3.0	78.7	30
40	.1	87.5	.4	85.9	.7	84.3	1.1	82.7	1.7	81.1	2.4	79.5	3.2	77.9	40
50	.1	87.4	.4	85.6	.8	83.9	1.2	82.1	1.8	80.4	2.6	78.7	3.4	77.0	50
88 0	0.1	87.1	0.4	85.2	0.8	83.3	1.3	81.5	2.0	79.6	2.8	77.8	3.7	76.0	88 0
5	.2	87.0	.4	85.0	.8	83.1	1.4	81.1	2.1	79.2	2.9	77.3	3.8	75.4	5
10	.2	86.9	.5	84.8	.9	82.7	1.5	80.7	2.2	78.7	3.0	76.7	4.0	74.7	10
15	.2	86.7	.5	84.6	.9	82.4	1.5	80.3	2.3	78.2	3.2	76.1	4.2	74.1	15
20	.2	86.6	.5	84.3	1.0	82.0	1.6	79.8	2.4	77.6	3.3	75.4	4.4	73.3	20
25	.2	86.4	.5	84.0	1.0	81.6	1.7	79.3	2.5	77.0	3.5	74.7	4.6	72.5	25
30	0.2	86.2	0.6	83.7	1.1	81.2	1.8	78.7	2.7	76.3	3.7	73.9	4.9	71.6	30
35	.2	86.0	.6	83.3	1.1	80.6	1.9	78.0	2.8	75.5	3.9	73.0	5.1	70.6	35
40	.2	85.7	.6	82.9	1.2	80.1	2.0	77.3	3.0	74.6	4.1	72.0	5.4	69.4	40
45	.2	85.4	.7	82.4	1.3	79.4	2.1	76.5	3.2	73.7	4.4	70.9	5.8	68.2	45
50	.3	85.1	.7	81.9	1.4	78.7	2.3	75.6	3.4	72.6	4.7	69.6	6.2	66.8	50
55	.3	84.7	.8	81.3	1.5	77.8	2.4	74.5	3.6	71.3	5.0	68.2	6.6	65.2	55
89 0	0.3	84.3	0.8	80.5	1.6	76.9	2.6	73.3	3.9	69.9	5.4	66.6	7.0	63.4	89 0
3	.3	84.0	.9	80.0	1.7	76.2	2.8	72.5	4.1	68.9	5.7	65.5	7.4	62.2	3
6	.3	83.7	.9	79.5	1.8	75.5	2.9	71.6	4.3	67.8	5.9	64.3	7.8	60.9	6
9	.4	83.3	1.0	78.9	1.9	74.6	3.1	70.6	4.5	66.7	6.3	63.0	8.2	59.5	9
12	0.4	82.9	1.0	78.2	2.0	73.7	3.3	69.4	4.8	65.4	6.6	61.6	8.6	58.0	12
15	.4	82.4	1.1	77.5	2.1	72.7	3.5	68.2	5.1	63.9	7.0	60.0	9.1	56.3	15
18	.4	81.9	1.2	76.6	2.3	71.6	3.7	66.8	5.4	62.4	7.4	58.3	9.6	54.5	18
21	.5	81.3	1.3	75.6	2.4	70.3	3.9	65.2	5.8	60.6	7.9	56.3	10.2	52.4	21
24	0.5	80.5	1.4	74.5	2.6	68.7	4.2	63.4	6.2	58.6	8.4	54.2	10.9	50.2	24
26	.5	80.0	1.5	73.6	2.8	67.6	4.5	62.1	6.5	57.1	8.8	52.6	11.3	48.6	26
28	.6	79.4	1.5	72.6	2.9	66.6	4.7	60.6	6.8	55.5	9.2	50.9	11.9	46.8	28
30	.6	78.7	1.6	71.6	3.1	65.0	5.0	59.0	7.2	53.7	9.7	49.1	12.4	45.0	30

Conversion of Hours and Minutes into Decimal Parts of a Day.

h m	D.P.	h m	D.P.	h m	D.P.	h m	D.P.	h m	D.P.	h m	D.P.
0 0	0.000	4 0	0.167	8 0	0.333	12 0	0.500	16 0	0.667	20 0	0.833
10	.007	10	.174	10	.340	10	.507	10	.674	10	.840
20	.014	20	.181	20	.347	20	.514	20	.681	20	.847
30	.021	30	.188	30	.354	30	.521	30	.688	30	.854
40	.028	40	.194	40	.361	40	.528	40	.694	40	.861
50	.035	50	.201	50	.368	50	.535	50	.701	50	.868
1 0	0.042	5 0	0.208	9 0	0.375	13 0	0.542	17 0	0.708	21 0	0.875
10	.049	10	.215	10	.382	10	.549	10	.715	10	.882
20	.056	20	.222	20	.389	20	.556	20	.722	20	.889
30	.063	30	.229	30	.396	30	.563	30	.729	30	.896
40	.069	40	.236	40	.403	40	.569	40	.736	40	.903
50	.076	50	.243	50	.410	50	.576	50	.743	50	.910
2 0	0.083	6 0	0.250	10 0	0.417	14 0	0.583	18 0	0.750	22 0	0.917
10	.090	10	.257	10	.424	10	.590	10	.757	10	.924
20	.097	20	.264	20	.431	20	.597	20	.764	20	.931
30	.104	30	.271	30	.438	30	.604	30	.771	30	.938
40	.111	40	.278	40	.444	40	.611	40	.778	40	.944
50	.118	50	.285	50	.451	50	.618	50	.785	50	.951
3 0	0.125	7 0	0.292	11 0	0.458	15 0	0.625	19 0	0.792	23 0	0.958
10	.132	10	.299	10	.465	10	.632	10	.799	10	.965
20	.139	20	.306	20	.472	20	.639	20	.806	20	.972
30	.146	30	.313	30	.479	30	.646	30	.813	30	.979
40	.153	40	.319	40	.486	40	.653	40	.819	40	.986
50	.160	50	.326	50	.493	50	.660	50	.826	50	.993
4 0	0.167	8 0	0.333	12 0	0.500	16 0	0.667	20 0	0.833	24 0	1.000

Conversion of Intervals of Sidereal Time into Equivalent Intervals of Mean Solar Time.

Sidereal Interval.	Mean Interval.	Sidereal Interval.	Mean Interval.	Sidereal Interval.	Mean Interval.	Sidereal Interval.	Mean Interval.
h m	h m s	h m	h m s	h m	h m s	h m	h m s
23 30	23 26 9.0	23 45	23 41 6.6	24 0	23 56 4.1	24 15	24 11 1.6
31	27 8.8	46	42 6.4	1	57 3.9	16	12 1.5
32	28 8.7	47	43 6.2	2	58 3.8	17	13 1.3
33	29 8.5	48	44 6.1	3	59 3.6	18	14 1.1
34	30 8.4	49	45 5.9	4	24 0 3.4	19	15 1.0
23 35	23 31 8.2	23 50	23 46 5.7	24 5	24 1 3.3	24 20	24 16 0.8
36	32 8.0	51	47 5.6	6	2 3.1	21	17 0.7
37	33 7.8	52	48 5.4	7	3 2.9	22	18 0.5
38	34 7.7	53	49 5.2	8	4 2.8	23	19 0.3
39	35 7.5	54	50 5.1	9	5 2.6	24	20 0.2
23 40	23 36 7.4	23 55	23 51 4.9	24 10	24 6 2.5	24 25	24 21 0.0
41	37 7.2	56	52 4.7	11	7 2.3	26	21 59.8
42	38 7.0	57	53 4.6	12	8 2.1	27	22 59.7
43	39 6.9	58	54 4.4	13	9 1.9	28	23 59.5
44	40 6.7	59	55 4.3	14	10 1.8	29	24 59.3

This table is used in connection with the daily comparison of mean and sidereal time chronometers.

NEW ALTITUDE TABLES

A description of these Tables in Portuguese will be found in the *Revista Maritima Brazileira* for February, 1912, page 1335.

HOW TO COMPUTE THE ALTITUDE OF A CELESTIAL BODY BY MEANS OF THE FOLLOWING TABLES

When the Hour Angle (t) and the Declination (d) of a celestial body are given and also the Latitude (L) of the observer we may calculate very easily, very rapidly and with as great accuracy as necessary the Altitude (h) of a celestial body as follows:

In the fundamental equation

(1) $$\cos(90°-h) \text{ or } \sin h = \sin L \sin d + \cos L \cos d \cos t$$

we make

$$\cos t = 1 - 2\sin^2\frac{t}{2}$$

and we have

(2) $$\cos(90°-h) = \cos(L-d) - 2\cos L \cos d \sin^2\frac{t}{2}$$

or $$1-\cos(90°-h) = 1-\cos(L-d) + 2\cos L \cos d \sin^2\frac{t}{2}.$$

If we make

(3) $$2\cos L \cos d \sin^2\frac{t}{2} = \text{versine } \theta = 2\sin^2\frac{\theta}{2}$$

we will have finally

(4) $$\text{versine}(90°-h) = \text{versine}(L-d) + \text{versine } \theta$$

Inverting equation (3), viz.:

$$2\cos L \cos d \sin^2\frac{t}{2} = 2\sin^2\frac{\theta}{2}$$

and multiplying both members by 2 we have

$$\sec L \sec d \operatorname{cosec}^2\frac{t}{2} = \operatorname{cosec}^2\frac{\theta}{2}$$

Applying logarithms to both members and dividing by 2 we have

(5) $$1/2 \log\sec L + 1/2 \log\sec d + \log\operatorname{cosec}\frac{t}{2} = \log\operatorname{cosec}\frac{\theta}{2}$$

Therefore by means of formulæ (4) and (5) we can determine the Altitude with the aid of the following Tables.

The Tables on pages 2* to 9* give us 1/2 log sec L or 1/2 log sec d.

The Tables on pages 10* to 27* give us in columns marked "*Hour Angle*" the log cosec $\frac{t}{2}$ or log cosec $\frac{\theta}{2}$ when we enter with t or θ as arguments.

In columns marked "*Sum or Diff.*" we find versine $(L-d)$ and also in the same columns versine θ corresponding to the log cosec $\frac{\theta}{2}$ given in columns marked "Hour Angle."

The Tables on pages 28* to 36* give us log cosec $\frac{t}{2}$ when t is comprised between 90° and 270°.

The Altitude corresponding to versine $(90°-h)$ will be found from below in columns marked "Alt.," the minutes of which are to be found on the right hand side of the pages.

Each versine and logarithm has been multiplied by 10^6 in order to reduce it to a whole number. On this account no characteristics appear and no periods also.

The numbers given correspond to six decimal places. When only five decimal place accuracy is desired drop the figure after the space or round up the fifth figure.

EXAMPLE I

Greenwich Hour Angle West.

The following expressions give us the value of $t_{o.}$—*the Greenwich Hour Angle West:*

$t_{o.}$ = G. M. T. − Eq. of T. for the ⊙

$t_{o.}$ = G. M. T. + R. A. M. S − R. A. for ✳, ☾, and planets.

Local Hour Angle West.

Once known $t_{o.}$ the *local hour angle west* (t) is given by the expression

$$t = t_{o.} \mp G$$

(− when G is West and + when G is East) G standing for Longitude.

When $t_{o.}$ is smaller than G add 360° to $t_{o.}$ If $t_{o.} + G$ is larger than 360° drop 360° from it.

Example I.

On February 21, 1910, about 8^h A.M. in Lat. by D. R. = 36° 52′ N and Long. by D.R. = 8° 6′ W the Sun's true altitude was 21° 7′ at $21^h\ 6^m\ 11^s$ of the chronometer, $6^m\ 59^s$ slow of G. M. T. Required the D. R. altitude.

C. = $21^h\ 6^m\ 11^s$
C. C. = + 6 59
G. M. T. = $21^h\ 13^m\ 10^s$
Eq. of T. = − 13 46
G. A. T. = $20^h\ 59^m\ 24^s$ or $t_{o.} = 314°\ 51'$
$G_{W.} = 8\ 6$
$t = 306°\ 45'$

$t = 306°\ 45'$	[log cosec $\frac{t}{2}$]	34858	
$L = 36\ 52$ N	[1/2 log sec L]	4845	
$d = 10\ 27$ S	[1/2 log sec d]	363	
	[log cosec $\frac{\theta}{2}$]	40066 . .	31609 [versine θ]
$L + d = 47°\ 19'$			32205 [versine $(L+d)$]
			63814 [versine $(90° - h)$]
			$h = 21°\ 13'$

Explanation.

After applying the correction to the chronometer time and the equation of time to the G. M. T. we find the G. A. T. or $t_{o.}$ —the Sun's Greenwich Hour Angle West— $t_{o.}$ being G. A. T. *converted into arc.*[1] The longitude by D. R. is combined with this $t_{o.}$ giving us t: the local hour angle west. Thus we have $t = 306°\ 45'$.

[1] This procedure, not usually followed in the text books, has the *triple* advantage of simplifying the determination of t, abolishing the argument in time in the tables and the necessity of dealing with data expressed in time and in arc after G. A. T. is converted.

The declination of the Sun, found in the *Nautical Almanac* at the same time as the Eq. of T., is taken to the nearest minute of arc. It is combined with the latitude, as shown.

When L and d are of the *same name*, both N or both S, subtract the smaller of the two from the larger. If they are of *contrary names*, as in our Examples, one N and the other S, add them together. We find $L+d=47^\circ\ 19'$.

Entering the "Latitude or Declination" Tables with $L=36^\circ\ 52'$ we find on page 5*: 4845, and with $d=10^\circ\ 27'$ we find on page 3*: 363.

Entering the tables on page 20* from below[1] with $t=306^\circ\ 45'$ in the "Hour Angle" column we find 34858, which, added to the numbers corresponding to L and d, gives us 40066.

We look for this number 40066 on page 19* in the same "Hour Angle" column, and opposite it in column "Sum or Diff." we find 31609. Adding to this number 31609 the number 32205 found on page 19* corresponding to $47^\circ\ 19'$ in "Sum or Diff." column we have 63814. This number corresponds to $21^\circ\ 13'$ in the "Alt." column on page 23*.

Therefore the altitude from D. R. is $21^\circ\ 13'$.

Example II.

On August 21, 1908, about 11^h A.M. in Lat. by D. R. $=16^\circ\ 34'$ S. and Long. by D. R. $=38^\circ\ 11'$ W. the Sun's true altitude was $59^\circ\ 10'$ at $1^h\ 19^m\ 40^s$ of the chronometer $26^m\ 59^s$ slow of G. M. T. Required the D. R. altitude.

C. $=1^h\ 19^m\ 40^s$
C. C. $=+\ 26\ 59$
G. M. T. $=1^h\ 46^m\ 39^s$
Eq. of T. $=-\ 3\ 3$
G. A. T. $=1^h\ 43^m\ 36^s$ or $t_{\odot}=25^\circ\ 54'$
$360^\circ+t_{\odot}=385^\circ\ 54'$
$G_{W.}=38\ 11$
$t=347^\circ\ 43'$

$t=347^\circ\ 43'$ 97067
$L=16\ 34$ S 921
$d=12\ 10$ N 493
98481 . . . 2143
$L+d=28^\circ\ 44'$ 12313
14456
$h=58^\circ\ 49'$

How to Find the Azimuth.

The Azimuth can be readily and easily found by methods explained on pages xxxvii and xxxviii of the "Altitude and Azimuth Tables."

For the sake of further exercise we will find the Azimuth in one of the two examples above.

Example. Given $t=53^\circ\ 15'$ E, $d=10^\circ\ 27'$ S and $L=36^\circ\ 52'$ N. Find the Azimuth.

---

[1] When t is smaller than 180° we enter the tables at the top and the body is West of the meridian; when t is greater than 180° we enter the tables from below and the body is East of the meridian.

Entering the tables with $d = 10° 30'$ and $t = 53°$ we find on page 69: $a = 52° 0'$ and $b = 17°$. Combining b with L we have $C = 54°$ and entering the tables again with $a = 52° 0'$ and $C = 54°$ we find $Z = 57° 42'$.

Generally (when $Z < 70°$) it will not be necessary to combine b and L. It is only necessary to run down column $\frac{d}{h}$ corresponding to $a = 52° 0'$ until we find $h = 21° 13$ and alongside the value of the altitude we would find $Z = 57° 42'$.

In the same way we would find $Z = 23° 41'$ in the second example.

NOTE.—It is evident that the Hour Angle t can be found given L, d and h by using backwards the process for finding h given L, d and t.

The author takes this opportunity to thank his good friend Lieutenant Renato Bayardino, Brazilian Navy, for his kindness in organising the "Latitude or Declination" Tables and for carefully revising with him these new Altitude Tables.

′	Latitude or Declination										′
	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	
0	0 0	3 3	13 3	29 8	53 0	82 8	119 3	162 5	212 4	269 0	0
1	0 0	3 4	13 5	30 1	53 4	83 3	120 0	163 2	213 3	270 0	1
2	0 0	3 5	13 7	30 4	53 9	83 9	120 6	164 0	214 1	271 0	2
3	0 0	3 6	13 9	30 8	54 3	84 5	121 3	164 8	215 0	272 0	3
4	0 0	3 8	14 1	31 1	54 7	85 0	122 0	165 6	215 9	273 0	4
5	0 0	3 9	14 4	31 5	55 2	85 6	122 6	166 4	216 8	274 0	5
6	0 0	4 0	14 6	31 8	55 7	86 2	123 3	167 2	217 7	275 0	6
7	0 0	4 1	14 8	32 2	56 1	86 7	124 0	167 9	218 6	276 1	7
8	0 1	4 3	15 1	32 5	56 6	87 3	124 7	168 7	219 5	277 1	8
9	0 1	4 4	15 3	32 8	57 0	87 8	125 3	169 5	220 4	278 1	9
10	0 1	4 5	15 5	33 2	57 5	88 4	126 0	170 3	221 3	279 1	10
11	0 1	4 6	15 7	33 5	57 9	89 0	126 7	171 1	222 2	280 1	11
12	0 1	4 8	16 0	33 9	58 4	89 6	127 4	171 9	223 2	281 1	12
13	0 2	4 9	16 3	34 2	58 9	90 2	128 1	172 7	224 1	282 2	13
14	0 2	5 0	16 5	34 6	59 3	90 7	128 8	173 5	225 0	283 2	14
15	0 2	5 2	16 8	35 0	59 8	91 3	129 5	174 3	225 9	284 2	15
16	0 2	5 3	17 0	35 3	60 3	91 9	130 1	175 1	226 8	285 3	16
17	0 3	5 4	17 3	35 7	60 7	92 5	130 8	175 9	227 7	286 3	17
18	0 3	5 6	17 5	36 0	61 2	93 0	131 5	176 7	228 6	287 3	18
19	0 3	5 7	17 8	36 4	61 7	93 6	132 2	177 5	229 6	288 4	19
20	0 4	5 9	18 0	36 8	62 2	94 2	132 9	178 4	230 5	289 4	20
21	0 4	6 0	18 3	37 2	62 7	94 8	133 6	179 2	231 4	290 4	21
22	0 4	6 2	18 5	37 5	63 1	95 4	134 3	180 0	232 3	291 5	22
23	0 5	6 3	18 8	37 9	63 6	96 0	135 0	180 8	233 3	292 5	23
24	0 5	6 5	19 1	38 3	64 1	96 6	135 8	181 6	234 2	293 6	24
25	0 6	6 6	19 3	38 6	64 6	97 2	136 5	182 5	235 1	294 6	25
26	0 6	6 8	19 6	39 0	65 1	97 8	137 2	183 3	236 1	295 7	26
27	0 7	7 0	19 9	39 4	65 6	98 4	137 9	184 1	237 0	296 7	27
28	0 7	7 1	20 1	39 8	66 1	99 0	138 6	184 9	238 0	297 8	28
29	0 8	7 3	20 4	40 2	66 5	99 6	139 3	185 7	238 9	298 8	29
30	0 8	7 4	20 7	40 5	67 0	100 2	140 0	186 6	239 8	299 9	30
31	0 9	7 6	21 0	40 9	67 5	100 8	140 8	187 4	240 8	300 9	31
32	0 9	7 8	21 2	41 3	68 0	101 4	141 5	188 2	241 7	302 0	32
33	1 0	7 9	21 5	41 7	68 5	102 0	142 2	189 1	242 7	303 0	33
34	1 1	8 1	21 8	42 1	69 0	102 7	142 9	189 9	243 6	304 1	34
35	1 1	8 3	22 1	42 5	69 6	103 3	143 7	190 8	244 6	305 2	35
36	1 2	8 5	22 4	42 9	70 1	103 9	144 4	191 6	245 5	306 2	36
37	1 3	8 6	22 7	43 3	70 6	104 5	145 1	192 4	246 5	307 3	37
38	1 4	8 8	22 9	43 7	71 1	105 1	145 9	193 3	247 5	308 4	38
39	1 4	9 0	23 2	44 1	71 6	105 8	146 6	194 1	248 4	309 5	39
40	1 5	9 2	23 5	44 5	72 1	106 4	147 3	195 0	249 4	310 5	40
41	1 5	9 4	23 8	44 9	72 6	107 0	148 1	195 8	250 3	311 6	41
42	1 6	9 6	24 1	45 3	73 1	107 6	148 8	196 7	251 3	312 7	42
43	1 7	9 8	24 4	45 7	73 7	108 3	149 6	197 5	252 3	313 8	43
44	1 8	9 9	24 7	46 1	74 2	108 9	150 3	198 4	253 2	314 9	44
45	1 9	10 1	25 0	46 5	74 7	109 5	151 0	199 3	254 2	315 9	45
46	1 9	10 3	25 3	47 0	75 3	110 2	151 8	200 1	255 2	317 0	46
47	2 0	10 5	25 6	47 4	75 8	110 8	152 5	201 0	256 2	318 1	47
48	2 1	10 7	25 9	47 8	76 3	111 5	153 3	201 8	257 1	319 2	48
49	2 2	10 9	26 2	48 2	76 8	112 1	154 0	202 7	258 1	320 3	49
50	2 3	11 1	26 6	48 6	77 4	112 7	154 8	203 6	259 1	321 4	50
51	2 4	11 3	26 9	49 1	77 9	113 4	155 6	204 4	260 1	322 5	51
52	2 5	11 5	27 2	49 5	78 4	114 0	156 3	205 3	261 1	323 6	52
53	2 6	11 7	27 5	49 9	79 0	114 7	157 1	206 2	262 0	324 7	53
54	2 7	11 9	27 8	50 3	79 5	115 4	157 8	207 1	263 0	325 8	54
55	2 8	12 2	28 2	50 8	80 1	116 0	158 6	208 0	264 0	326 9	55
56	2 9	12 4	28 5	51 2	80 6	116 6	159 4	208 8	265 0	328 0	56
57	3 0	12 6	28 8	51 7	81 2	117 3	160 1	209 7	266 0	329 1	57
58	3 1	12 8	29 1	52 1	81 7	118 0	160 9	210 6	267 0	330 2	58
59	3 2	13 0	29 5	52 5	82 2	118 6	161 7	211 5	268 0	331 3	59
60	3 3	13 3	29 8	53 0	82 8	119 3	162 5	212 4	269 0	332 4	60
	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	
	Latitude or Declination										

′	Latitude or Declination										′
	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	
0	332 4	402 7	479 8	563 8	654 8	752 8	857 9	970 2	1089 7	1216 5	0
1	333 5	403 9	481 1	565 3	656 4	754 5	859 7	972 1	1091 7	1218 7	1
2	334 7	405 1	482 5	566 7	658 0	756 2	861 5	974 1	1093 8	1220 9	2
3	335 8	406 4	483 8	568 2	659 5	757 9	863 4	976 0	1095 9	1223 0	3
4	336 9	407 6	485 2	569 7	661 1	759 6	865 2	977 9	1097 9	1225 2	4
5	338 0	408 8	486 5	571 1	662 7	761 3	867 0	979 9	1100 0	1227 4	5
6	339 1	410 1	487 9	572 6	664 3	763 0	868 8	981 8	1102 0	1229 6	6
7	340 3	411 3	489 2	574 1	665 9	764 7	870 6	983 8	1104 1	1231 8	7
8	341 4	412 6	490 6	575 5	667 5	766 4	872 5	985 7	1106 2	1234 0	8
9	342 5	413 8	491 9	577 0	669 0	768 1	874 3	987 6	1108 2	1236 2	9
10	343 7	415 0	493 3	578 5	670 6	769 8	876 1	989 6	1110 3	1238 4	10
11	344 8	416 3	494 7	580 0	672 2	771 6	878 0	991 6	1112 4	1240 6	11
12	345 9	417 5	496 0	581 4	673 8	773 3	879 8	993 5	1114 5	1242 8	12
13	347 1	418 8	497 4	582 9	675 4	775 0	881 6	995 5	1116 5	1245 0	13
14	348 2	420 1	498 8	584 4	677 0	776 7	883 5	997 4	1118 6	1247 2	14
15	349 3	421 3	500 1	585 9	678 6	778 4	885 3	999 4	1120 7	1249 4	15
16	350 5	422 6	501 5	587 4	680 2	780 1	887 2	1001 4	1122 8	1251 6	16
17	351 7	423 8	502 9	588 9	681 9	781 9	889 0	1003 3	1124 9	1253 8	17
18	352 8	425 1	504 3	590 4	683 5	783 6	890 8	1005 3	1127 0	1256 0	18
19	353 9	426 3	505 6	591 9	685 1	785 3	892 7	1007 2	1129 0	1258 2	19
20	355 1	427 6	507 0	593 4	686 7	787 1	894 5	1009 2	1131 1	1260 4	20
21	356 2	428 9	508 4	594 9	688 3	788 8	896 4	1011 2	1133 2	1262 6	21
22	357 4	430 1	509 8	596 4	689 9	790 5	898 2	1013 2	1135 3	1264 8	22
23	358 5	431 4	511 2	597 9	691 5	792 3	900 1	1015 2	1137 4	1267 1	23
24	359 7	432 7	512 6	599 4	693 2	794 0	902 0	1017 1	1139 5	1269 3	24
25	360 9	434 0	513 9	600 9	694 8	795 7	903 8	1019 1	1141 6	1271 5	25
26	362 0	435 2	515 3	602 4	696 4	797 5	905 7	1021 1	1143 7	1273 7	26
27	363 2	436 5	516 7	603 9	698 0	799 2	907 6	1023 1	1145 8	1276 0	27
28	364 4	437 8	518 1	605 4	699 7	801 0	909 4	1025 0	1148 0	1278 2	28
29	365 5	439 1	519 5	606 9	701 3	802 7	911 3	1027 0	1150 1	1280 4	29
30	366 7	440 4	520 9	608 4	702 9	804 5	913 2	1029 0	1152 2	1282 7	30
31	367 9	441 7	522 3	609 9	704 6	806 2	915 0	1031 0	1154 3	1284 9	31
32	369 0	442 9	523 7	611 5	706 2	808 0	916 9	1033 0	1156 4	1287 2	32
33	370 2	444 2	525 1	613 0	707 8	809 7	918 8	1035 0	1158 5	1289 4	33
34	371 4	445 5	526 5	614 5	709 5	811 5	920 7	1037 0	1160 6	1291 6	34
35	372 6	446 8	528 0	616 0	711 1	813 3	922 5	1039 0	1162 8	1293 9	35
36	373 8	448 1	529 4	617 6	712 8	815 0	924 4	1041 0	1164 9	1296 1	36
37	374 9	449 4	530 8	619 1	714 4	816 8	926 3	1043 0	1167 0	1298 4	37
38	376 1	450 7	532 2	620 6	716 1	818 6	928 2	1045 0	1169 1	1300 6	38
39	377 3	452 0	533 6	622 2	717 7	820 3	930 1	1047 0	1171 3	1302 9	39
40	378 5	453 3	535 0	623 7	719 4	822 1	932 0	1049 0	1173 4	1305 1	40
41	379 7	454 6	536 4	625 2	721 0	823 9	933 9	1051 1	1175 5	1307 4	41
42	380 9	455 9	537 9	626 8	722 7	825 6	935 8	1053 1	1177 7	1309 7	42
43	382 1	457 2	539 3	628 3	724 3	827 4	937 7	1055 1	1179 8	1311 9	43
44	383 3	458 5	540 7	629 8	726 0	829 2	939 6	1057 1	1182 0	1314 2	44
45	384 5	459 9	542 1	631 4	727 6	831 0	941 5	1059 1	1184 1	1316 5	45
46	385 7	461 2	543 6	632 9	729 3	832 8	943 4	1061 2	1186 3	1318 7	46
47	386 9	462 5	545 0	634 5	731 0	834 6	945 3	1063 2	1188 4	1321 0	47
48	388 1	463 8	546 4	636 0	732 6	836 3	947 2	1065 2	1190 5	1323 3	48
49	389 3	465 1	547 9	637 6	734 3	838 1	949 1	1067 2	1192 7	1325 5	49
50	390 5	466 5	549 3	639 1	736 0	839 9	951 0	1069 3	1194 9	1327 8	50
51	391 7	467 8	550 8	640 7	737 7	841 7	952 9	1071 3	1197 0	1330 1	51
52	392 9	469 1	552 2	642 3	739 3	843 5	954 8	1073 3	1199 2	1332 4	52
53	394 1	470 4	553 6	643 8	741 0	845 3	956 7	1075 4	1201 3	1334 7	53
54	395 3	471 8	555 1	645 4	742 7	847 1	958 6	1077 4	1203 5	1337 0	54
55	396 6	473 1	556 5	646 9	744 4	848 9	960 6	1079 4	1205 7	1339 2	55
56	397 8	474 4	558 0	648 5	746 1	850 7	962 5	1081 5	1207 8	1341 5	56
57	399 0	475 8	559 4	650 1	747 7	852 5	964 4	1083 5	1210 0	1343 8	57
58	400 2	477 1	560 9	651 7	749 4	854 3	966 3	1085 6	1212 2	1346 1	58
59	401 4	478 4	562 3	653 2	751 1	856 1	968 3	1087 6	1214 3	1348 4	59
60	402 7	479 8	563 8	654 8	752 8	857 9	970 2	1089 7	1216 5	1350 7	60
	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	
	Latitude or Declination										

′	Latitude or Declination										′
	20°	21°	22°	23°	24°	25°	26°	27°	28°	29°	
0	1350 7	1492 4	1641 7	1798 7	1963 5	2136 2	2317 0	2506 0	2703 3	2909 0	0
1	1353 0	1494 8	1644 3	1801 4	1966 3	2139 2	2320 1	2509 2	2706 6	2912 5	1
2	1355 3	1497 3	1646 8	1804 1	1969 1	2142 1	2323 2	2512 4	2710 0	2916 0	2
3	1357 6	1499 7	1649 4	1806 8	1971 9	2145 1	2326 2	2515 6	2713 3	2919 6	3
4	1359 9	1502 1	1651 9	1809 4	1974 8	2148 0	2329 3	2518 9	2716 7	2923 1	4
5	1362 2	1504 6	1654 5	1812 1	1977 6	2151 0	2332 4	2522 1	2720 1	2926 6	5
6	1364 5	1507 0	1657 1	1814 8	1980 4	2153 9	2335 5	2525 3	2723 5	2930 1	6
7	1366 9	1509 4	1659 6	1817 5	1983 2	2156 9	2338 6	2528 5	2726 8	2933 6	7
8	1369 2	1511 9	1662 2	1820 2	1986 1	2159 9	2341 7	2531 8	2730 2	2937 1	8
9	1371 5	1514 3	1664 8	1822 9	1988 9	2162 8	2344 8	2535 0	2733 6	2940 6	9
10	1373 8	1516 8	1667 3	1825 6	1991 8	2165 8	2347 9	2538 3	2737 0	2944 2	10
11	1376 1	1519 2	1669 9	1828 3	1994 6	2168 8	2351 0	2541 5	2740 3	2947 7	11
12	1378 5	1521 7	1672 5	1831 0	1997 4	2171 7	2354 1	2544 8	2743 7	2951 2	12
13	1380 8	1524 1	1675 1	1833 7	2000 2	2174 7	2357 2	2548 0	2747 1	2954 8	13
14	1383 1	1526 6	1677 6	1836 4	2003 1	2177 7	2360 3	2551 2	2750 5	2958 3	14
15	1385 4	1529 0	1680 2	1839 2	2005 9	2180 7	2363 5	2554 5	2753 9	2961 8	15
16	1387 8	1531 5	1682 8	1841 9	2008 8	2183 6	2366 6	2557 8	2757 3	2965 4	16
17	1390 1	1533 9	1685 4	1844 6	2011 6	2186 6	2369 7	2561 0	2760 7	2968 9	17
18	1392 4	1536 4	1688 0	1847 3	2014 5	2189 6	2372 8	2564 3	2764 1	2972 5	18
19	1394 8	1538 9	1690 6	1850 0	2017 3	2192 6	2375 9	2567 5	2767 5	2976 0	19
20	1397 1	1541 3	1693 2	1852 8	2020 2	2195 6	2379 1	2570 8	2770 9	2979 5	20
21	1399 5	1543 8	1695 8	1855 5	2023 0	2198 6	2382 2	2574 1	2774 3	2983 1	21
22	1401 8	1546 3	1698 4	1858 2	2025 9	2201 6	2385 3	2577 3	2777 7	2986 7	22
23	1404 1	1548 7	1701 0	1860 9	2028 8	2204 6	2388 5	2580 6	2781 1	2990 2	23
24	1406 5	1551 2	1703 6	1863 7	2031 6	2207 6	2391 6	2583 9	2784 5	2993 8	24
25	1408 8	1553 7	1706 2	1866 4	2034 5	2210 6	2394 7	2587 1	2788 0	2997 3	25
26	1411 2	1556 2	1708 8	1869 1	2037 4	2213 6	2397 9	2590 4	2791 4	3000 9	26
27	1413 5	1558 7	1711 4	1871 9	2040 2	2216 6	2401 0	2593 7	2794 8	3004 5	27
28	1415 9	1561 1	1714 0	1874 6	2043 1	2219 6	2404 1	2597 0	2798 2	3008 0	28
29	1418 3	1563 6	1716 6	1877 4	2046 0	2222 6	2407 3	2600 3	2801 6	3011 6	29
30	1420 6	1566 1	1719 2	1880 1	2048 9	2225 6	2410 4	2603 6	2805 1	3015 2	30
31	1423 0	1568 6	1721 9	1882 9	2051 7	2228 6	2413 6	2606 8	2808 5	3018 7	31
32	1425 3	1571 1	1724 5	1885 6	2054 6	2231 6	2416 7	2610 1	2811 9	3022 3	32
33	1427 7	1573 6	1727 1	1888 4	2057 5	2234 6	2419 9	2613 4	2815 4	3025 9	33
34	1430 1	1576 1	1729 7	1891 1	2060 4	2237 7	2423 1	2616 7	2818 8	3029 5	34
35	1432 5	1578 6	1732 3	1893 9	2063 3	2240 7	2426 2	2620 0	2822 3	3033 1	35
36	1434 8	1581 1	1735 0	1896 6	2066 2	2243 7	2429 4	2623 3	2825 7	3036 6	36
37	1437 2	1583 6	1737 6	1899 4	2069 1	2246 7	2432 5	2626 6	2829 1	3040 2	37
38	1439 6	1586 1	1740 2	1902 2	2072 0	2249 8	2435 7	2629 9	2832 6	3043 8	38
39	1442 0	1588 6	1742 9	1904 9	2074 9	2252 8	2438 9	2633 2	2836 0	3047 4	39
40	1444 3	1591 1	1745 5	1907 7	2077 8	2255 8	2442 1	2636 6	2839 5	3051 0	40
41	1446 7	1593 6	1748 1	1910 5	2080 7	2258 9	2445 2	2639 9	2842 9	3054 6	41
42	1449 1	1596 1	1750 8	1913 2	2083 6	2261 9	2448 4	2643 2	2846 4	3058 2	42
43	1451 5	1598 6	1753 4	1916 0	2086 5	2265 0	2451 6	2646 5	2849 9	3061 8	43
44	1453 9	1601 1	1756 1	1918 8	2089 4	2268 0	2454 8	2649 8	2853 3	3065 4	44
45	1456 3	1603 7	1758 7	1921 6	2092 3	2271 0	2457 9	2653 1	2856 8	3069 0	45
46	1458 7	1606 2	1761 4	1924 3	2095 2	2274 1	2461 1	2656 5	2860 3	3072 7	46
47	1461 1	1608 7	1764 0	1927 1	2098 1	2277 1	2464 3	2659 8	2863 7	3076 3	47
48	1463 5	1611 2	1766 7	1929 9	2101 0	2280 2	2467 5	2663 1	2867 2	3079 9	48
49	1465 9	1613 8	1769 3	1932 7	2104 0	2283 2	2470 7	2666 5	2870 7	3083 5	49
50	1468 3	1616 3	1772 0	1935 5	2106 9	2286 3	2473 9	2669 8	2874 1	3087 1	50
51	1470 7	1618 8	1774 7	1938 3	2109 8	2289 4	2477 1	2673 1	2877 6	3090 7	51
52	1473 1	1621 4	1777 3	1941 1	2112 7	2292 4	2480 3	2676 5	2881 1	3094 4	52
53	1475 5	1623 9	1780 0	1943 9	2115 7	2295 5	2483 5	2679 8	2884 6	3098 0	53
54	1477 9	1626 4	1782 7	1946 7	2118 6	2298 5	2486 7	2683 1	2888 1	3101 6	54
55	1480 3	1629 0	1785 3	1949 5	2121 5	2301 6	2489 9	2686 5	2891 6	3105 3	55
56	1482 7	1631 5	1788 0	1952 3	2124 5	2304 7	2493 1	2689 8	2895 1	3108 9	56
57	1485 2	1634 1	1790 7	1955 1	2127 4	2307 8	2496 3	2693 2	2898 5	3112 5	57
58	1487 6	1636 6	1793 3	1957 9	2130 3	2310 8	2499 5	2696 5	2902 0	3116 2	58
59	1490 0	1639 2	1796 0	1960 7	2133 3	2313 9	2502 7	2699 9	2905 5	3119 8	59
60	1492 4	1641 7	1798 7	1963 5	2136 2	2317 0	2506 0	2703 3	2909 0	3123 5	60
	20°	21°	22°	23°	24°	25°	26°	27°	28°	29°	
	Latitude or Declination										

′	Latitude or Declination										′
	30°	31°	32°	33°	34°	35°	36°	37°	38°	39°	
0	3123 5	3346 7	3579 0	3820 4	4071 3	4331 8	4602 1	4882 6	5173 4	5474 9	0
1	3127 1	3350 5	3582 9	3824 5	4075 6	4336 2	4606 7	4887 3	5178 3	5480 0	1
2	3130 7	3354 3	3586 9	3828 6	4079 8	4340 6	4611 3	4892 1	5183 3	5485 1	2
3	3134 4	3358 1	3590 8	3832 8	4084 1	4345 1	4615 9	4896 9	5188 2	5490 2	3
4	3138 1	3361 9	3594 8	3836 9	4088 4	4349 5	4620 5	4901 6	5193 2	5495 4	4
5	3141 7	3365 7	3598 7	3841 0	4092 6	4353 9	4625 1	4906 4	5198 1	5500 5	5
6	3145 4	3369 5	3602 7	3845 1	4096 9	4358 4	4629 7	4911 2	5203 1	5505 6	6
7	3149 1	3373 4	3606 7	3849 2	4101 2	4362 8	4634 3	4916 0	5208 0	5510 8	7
8	3152 7	3377 2	3610 6	3853 3	4105 5	4367 2	4638 9	4920 7	5213 0	5515 9	8
9	3156 4	3381 0	3614 6	3857 5	4109 7	4371 7	4643 5	4925 5	5217 9	5521 0	9
10	3160 1	3384 8	3618 6	3861 6	4114 0	4376 1	4648 2	4930 3	5222 9	5526 2	10
11	3163 7	3388 6	3622 6	3865 7	4118 3	4380 6	4652 8	4935 1	5227 9	5531 3	11
12	3167 4	3392 4	3626 5	3869 8	4122 6	4385 0	4657 4	4939 9	5232 8	5536 5	12
13	3171 1	3396 3	3630 5	3874 0	4126 9	4389 5	4662 0	4944 7	5237 8	5541 6	13
14	3174 8	3400 1	3634 5	3878 1	4131 2	4394 0	4666 6	4949 5	5242 8	5546 8	14
15	3178 4	3403 9	3638 5	3882 3	4135 5	4398 4	4671 3	4954 3	5247 8	5551 9	15
16	3182 1	3407 8	3642 5	3886 4	4139 8	4402 9	4675 9	4959 1	5252 7	5557 1	16
17	3185 8	3411 6	3646 4	3890 5	4144 1	4407 4	4680 5	4963 9	5257 7	5562 3	17
18	3189 5	3415 4	3650 4	3894 7	4148 4	4411 8	4685 2	4968 7	5262 7	5567 4	18
19	3193 2	3419 3	3654 4	3898 8	4152 7	4416 3	4689 8	4973 5	5267 7	5572 6	19
20	3196 9	3423 1	3658 4	3903 0	4157 0	4420 8	4694 5	4978 3	5272 7	5577 8	20
21	3200 6	3427 0	3662 4	3907 2	4161 4	4425 3	4699 1	4983 2	5277 7	5583 0	21
22	3204 3	3430 8	3666 4	3911 3	4165 7	4429 7	4703 8	4988 0	5282 7	5588 1	22
23	3208 0	3434 7	3670 4	3915 5	4170 0	4434 2	4708 4	4992 8	5287 7	5593 3	23
24	3211 7	3438 5	3674 4	3919 6	4174 3	4438 7	4713 1	4997 6	5292 7	5598 5	24
25	3215 4	3442 4	3678 5	3923 8	4178 6	4443 2	4717 7	5002 5	5297 7	5603 7	25
26	3219 1	3446 3	3682 5	3928 0	4183 0	4447 7	4722 4	5007 3	5302 7	5608 9	26
27	3222 8	3450 1	3686 5	3932 1	4187 3	4452 2	4727 1	5012 1	5307 7	5614 1	27
28	3226 5	3454 0	3690 5	3936 3	4191 6	4456 7	4731 7	5017 0	5312 7	5619 3	28
29	3230 3	3457 8	3694 5	3940 5	4196 0	4461 2	4736 4	5021 8	5317 8	5624 5	29
30	3234 0	3461 7	3698 5	3944 7	4200 3	4465 7	4741 1	5026 7	5322 8	5629 7	30
31	3237 7	3465 6	3702 6	3948 9	4204 7	4470 2	4745 7	5031 5	5327 8	5634 9	31
32	3241 4	3469 5	3706 6	3953 0	4209 0	4474 7	4750 4	5036 4	5332 8	5640 1	32
33	3245 2	3473 3	3710 6	3957 2	4213 4	4479 2	4755 1	5041 2	5337 9	5645 3	33
34	3248 9	3477 2	3714 7	3961 4	4217 7	4483 7	4759 8	5046 1	5342 9	5650 6	34
35	3252 6	3481 1	3718 7	3965 6	4222 1	4488 3	4764 5	5050 9	5347 9	5655 8	35
36	3256 4	3485 0	3722 7	3969 8	4226 4	4492 8	4769 2	5055 8	5353 0	5661 0	36
37	3260 1	3488 9	3726 8	3974 0	4230 8	4497 3	4773 9	5060 7	5358 0	5666 2	37
38	3263 8	3492 8	3730 8	3978 2	4235 1	4501 8	4778 5	5065 5	5363 1	5671 5	38
39	3267 6	3496 7	3734 9	3982 4	4239 5	4506 4	4783 2	5070 4	5368 1	5676 7	39
40	3271 3	3500 5	3738 9	3986 6	4243 9	4510 9	4787 9	5075 3	5373 2	5681 9	40
41	3275 1	3504 4	3743 0	3990 8	4248 2	4515 4	4792 7	5080 2	5378 2	5687 2	41
42	3278 8	3508 3	3747 0	3995 0	4252 6	4520 0	4797 4	5085 0	5383 3	5692 4	42
43	3282 6	3512 2	3751 1	3999 2	4257 0	4524 5	4802 1	5089 9	5388 4	5697 7	43
44	3286 3	3516 2	3755 1	4003 5	4261 4	4529 1	4806 8	5094 8	5393 4	5702 9	44
45	3290 1	3520 1	3759 2	4007 7	4265 7	4533 6	4811 5	5099 7	5398 5	5708 2	45
46	3293 8	3524 0	3763 3	4011 9	4270 1	4538 1	4816 2	5104 6	5403 6	5713 4	46
47	3297 6	3527 9	3767 3	4016 1	4274 5	4542 7	4820 9	5109 5	5408 6	5718 7	47
48	3301 4	3531 8	3771 4	4020 4	4278 9	4547 3	4825 7	5114 4	5413 7	5723 9	48
49	3305 1	3535 7	3775 5	4024 6	4283 3	4551 8	4830 4	5119 3	5418 8	5729 2	49
50	3308 9	3539 6	3779 5	4028 8	4287 7	4556 4	4835 1	5124 2	5423 9	5734 5	50
51	3312 7	3543 6	3783 6	4033 1	4292 1	4560 9	4839 8	5129 1	5429 0	5739 7	51
52	3316 4	3547 5	3787 7	4037 3	4296 5	4565 5	4844 6	5134 0	5434 0	5745 0	52
53	3320 2	3551 4	3791 8	4041 5	4300 9	4570 1	4849 3	5138 9	5439 1	5750 3	53
54	3324 0	3555 3	3795 9	4045 8	4305 3	4574 6	4854 1	5143 8	5444 2	5755 6	54
55	3327 8	3559 3	3800 0	4050 0	4309 7	4579 2	4858 8	5148 8	5449 3	5760 8	55
56	3331 6	3563 2	3804 0	4054 3	4314 1	4583 8	4863 6	5153 7	5454 4	5766 1	56
57	3335 3	3567 1	3808 1	4058 5	4318 5	4588 4	4868 3	5158 6	5459 5	5771 4	57
58	3339 1	3571 1	3812 2	4062 8	4322 9	4592 9	4873 1	5163 5	5464 6	5776 7	58
59	3342 9	3575 0	3816 3	4067 0	4327 4	4597 5	4877 8	5168 5	5469 8	5782 0	59
60	3346 7	3579 0	3820 4	4071 3	4331 8	4602 1	4882 6	5173 4	5474 9	5787 3	60
	30°	31°	32°	33°	34°	35°	36°	37°	38°	39°	
	Latitude or Declination										

′	Latitude or Declination										′
	40°	41°	42°	43°	44°	45°	46°	47°	48°	49°	
0	5787 3	6111 0	6446 3	6793 6	7153 3	7525 8	7911 4	8310 8	8724 5	9152 9	0
1	5792 6	6116 5	6452 0	6799 5	7159 4	7532 1	7918 0	8317 6	8731 5	9160 1	1
2	5797 9	6122 0	6457 7	6805 4	7165 5	7538 4	7924 5	8324 4	8738 5	9167 4	2
3	5803 2	6127 5	6463 4	6811 3	7171 6	7544 7	7931 1	8331 2	8745 5	9174 7	3
4	5808 5	6133 0	6469 1	6817 2	7177 7	7551 0	7937 6	8338 0	8752 6	9182 0	4
5	5813 8	6138 5	6474 8	6823 1	7183 8	7557 4	7944 2	8344 8	8759 6	9189 2	5
6	5819 2	6144 0	6480 5	6829 0	7190 0	7563 7	7950 8	8351 6	8766 6	9196 5	6
7	5824 5	6149 5	6486 2	6834 9	7196 1	7570 1	7957 3	8358 4	8773 7	9203 8	7
8	5829 8	6155 0	6491 9	6840 9	7202 2	7576 4	7963 9	8365 2	8780 7	9211 1	8
9	5835 1	6160 6	6497 7	6846 8	7208 3	7582 8	7970 5	8372 0	8787 8	9218 4	9
10	5840 5	6166 1	6503 4	6852 7	7214 5	7589 1	7977 0	8378 8	8794 8	9225 7	10
11	5845 8	6171 6	6509 1	6858 6	7220 6	7595 5	7983 6	8385 6	8801 9	9233 0	11
12	5851 1	6177 1	6514 8	6864 6	7226 8	7601 8	7990 2	8392 4	8808 9	9240 4	12
13	5856 5	6182 7	6520 5	6870 5	7232 9	7608 2	7996 8	8399 2	8816 0	9247 7	13
14	5861 8	6188 2	6526 3	6876 4	7239 0	7614 5	8003 4	8406 1	8823 1	9255 0	14
15	5867 2	6193 7	6532 0	6882 4	7245 2	7620 9	8010 0	8412 9	8830 1	9262 3	15
16	5872 5	6199 3	6537 8	6888 3	7251 4	7627 3	8016 6	8419 7	8837 2	9269 7	16
17	5877 9	6204 8	6543 5	6894 3	7257 5	7633 7	8023 2	8426 6	8844 3	9277 0	17
18	5883 2	6210 4	6549 2	6900 2	7263 7	7640 0	8029 8	8433 4	8851 4	9284 3	18
19	5888 6	6215 9	6555 0	6906 2	7269 8	7646 4	8036 4	8440 3	8858 5	9291 7	19
20	5893 9	6221 5	6560 7	6912 1	7276 0	7652 8	8043 0	8447 1	8865 6	9299 0	20
21	5899 3	6227 0	6566 5	6918 1	7282 2	7659 2	8049 6	8454 0	8872 7	9306 4	21
22	5904 7	6232 6	6572 3	6924 1	7288 4	7665 6	8056 3	8460 8	8879 8	9313 8	22
23	5910 0	6238 2	6578 0	6930 0	7294 5	7672 0	8062 9	8467 7	8886 9	9321 1	23
24	5915 4	6243 7	6583 8	6936 0	7300 7	7678 4	8069 5	8474 5	8894 0	9328 5	24
25	5920 8	6249 3	6589 6	6942 0	7306 9	7684 8	8076 2	8481 4	8901 1	9335 9	25
26	5926 2	6254 9	6595 3	6947 9	7313 1	7691 2	8082 8	8488 3	8908 2	9343 2	26
27	5931 6	6260 4	6601 1	6953 9	7319 3	7697 6	8089 4	8495 2	8915 4	9350 6	27
28	5936 9	6266 0	6606 9	6959 9	7325 5	7704 1	8096 1	8502 1	8922 5	9358 0	28
29	5942 3	6271 6	6612 7	6965 9	7331 7	7710 5	8102 7	8508 9	8929 6	9365 4	29
30	5947 7	6277 2	6618 5	6971 9	7337 9	7716 9	8109 4	8515 8	8936 8	9372 8	30
31	5953 1	6282 8	6624 2	6977 9	7344 1	7723 3	8116 1	8522 7	8943 9	9380 2	31
32	5958 5	6288 4	6630 0	6983 9	7350 3	7729 8	8122 7	8529 6	8951 1	9387 6	32
33	5963 9	6294 0	6635 8	6989 9	7356 5	7736 2	8129 4	8536 5	8958 2	9395 0	33
34	5969 3	6299 6	6641 6	6995 9	7362 8	7742 7	8136 0	8543 4	8965 4	9402 4	34
35	5974 7	6305 2	6647 4	7001 9	7369 0	7749 1	8142 7	8550 4	8972 5	9409 8	35
36	5980 2	6310 8	6653 2	7007 9	7375 2	7755 5	8149 4	8557 3	8979 7	9417 2	36
37	5985 6	6316 4	6659 1	7013 9	7381 4	7762 0	8156 1	8564 2	8986 9	9424 7	37
38	5991 0	6322 0	6664 9	7020 0	7387 7	7768 5	8162 8	8571 1	8994 0	9432 1	38
39	5996 4	6327 6	6670 7	7026 0	7393 9	7774 9	8169 5	8578 0	9001 2	9439 5	39
40	6001 8	6333 2	6676 5	7032 0	7400 2	7781 4	8176 1	8585 0	9008 4	9447 0	40
41	6007 3	6338 9	6682 3	7038 0	7406 4	7787 8	8182 8	8591 9	9015 6	9454 4	41
42	6012 7	6344 5	6688 2	7044 1	7412 6	7794 3	8189 5	8598 8	9022 8	9461 8	42
43	6018 1	6350 1	6694 0	7050 1	7418 9	7800 8	8196 3	8605 8	9029 9	9469 3	43
44	6023 6	6355 8	6699 8	7056 2	7425 2	7807 3	8203 0	8612 8	9037 1	9476 8	44
45	6029 0	6361 4	6705 7	7062 2	7431 4	7813 8	8209 7	8619 7	9044 3	9484 2	45
46	6034 5	6367 0	6711 5	7068 2	7437 7	7820 2	8216 4	8626 6	9051 5	9491 7	46
47	6039 9	6372 7	6717 3	7074 3	7444 0	7826 7	8223 1	8633 6	9058 8	9499 1	47
48	6045 4	6378 3	6723 2	7080 4	7450 2	7833 2	8229 8	8640 6	9066 0	9506 6	48
49	6050 8	6384 0	6729 0	7086 4	7456 5	7839 7	8236 6	8647 5	9073 2	9514 1	49
50	6056 3	6389 6	6734 9	7092 5	7462 8	7846 2	8243 3	8654 5	9080 4	9521 6	50
51	6061 7	6395 3	6740 8	7098 5	7469 1	7852 7	8250 0	8661 5	9087 6	9529 1	51
52	6067 2	6400 9	6746 6	7104 6	7475 3	7859 2	8256 8	8668 5	9094 9	9536 5	52
53	6072 7	6406 6	6752 5	7110 7	7481 6	7865 7	8263 5	8675 5	9102 1	9544 0	53
54	6078 1	6412 3	6758 3	7116 8	7487 9	7872 3	8270 3	8682 4	9109 3	9551 5	54
55	6083 6	6417 9	6764 2	7122 8	7494 2	7878 8	8277 0	8689 4	9116 6	9559 0	55
56	6089 1	6423 6	6770 1	7128 9	7500 5	7885 3	8283 8	8696 4	9123 8	9566 6	56
57	6094 6	6429 3	6776 0	7135 0	7506 8	7891 8	8290 5	8703 4	9131 1	9574 1	57
58	6100 0	6435 0	6781 9	7141 1	7513 1	7898 4	8297 3	8710 4	9138 3	9581 6	58
59	6105 5	6440 6	6787 7	7147 2	7519 4	7904 9	8304 1	8717 4	9145 6	9589 1	59
60	6111 0	6446 3	6793 6	7153 3	7525 8	7911 4	8310 8	8724 5	9152 9	9596 6	60
	40°	41°	42°	43°	44°	45°	46°	47°	48°	49°	
	Latitude or Declination										

′	Latitude or Declination										′
	50°	51°	52°	53°	54°	55°	56°	57°	58°	59°	
0	9596 6	10056 4	10532 9	11026 9	11539 1	12070 4	12621 9	13194 6	13789 5	14408 0	0
1	9604 2	10064 2	10541 0	11035 2	11547 8	12079 5	12631 3	13204 3	13799 6	14418 6	1
2	9611 7	10072 0	10549 1	11043 6	11556 5	12088 5	12640 7	13214 0	13809 7	14429 1	2
3	9619 2	10079 8	10557 2	11052 0	11565 2	12097 5	12650 0	13223 8	13819 9	14439 6	3
4	9626 8	10087 7	10565 3	11060 4	11573 9	12106 6	12659 4	13233 5	13830 0	14450 1	4
5	9634 3	10095 5	10573 4	11068 8	11582 6	12115 6	12668 8	13243 3	13840 1	14460 7	5
6	9641 9	10103 3	10581 5	11077 2	11591 3	12124 7	12678 2	13253 0	13850 3	14471 2	6
7	9649 4	10111 1	10589 6	11085 7	11600 1	12133 7	12687 6	13262 8	13860 4	14481 8	7
8	9657 0	10119 0	10597 7	11094 1	11608 8	12142 8	12697 0	13272 6	13870 6	14492 4	8
9	9664 6	10126 8	10605 9	11102 5	11617 5	12151 9	12706 4	13282 4	13880 8	14502 9	9
10	9672 1	10134 6	10614 0	11110 9	11626 3	12160 9	12715 9	13292 1	13890 9	14513 5	10
11	9679 7	10142 5	10622 1	11119 4	11635 0	12170 0	12725 3	13301 9	13901 1	14524 1	11
12	9687 3	10150 4	10630 3	11127 8	11643 8	12179 1	12734 7	13311 7	13911 3	14534 7	12
13	9694 9	10158 2	10638 4	11136 3	11652 5	12188 2	12744 2	13321 5	13921 5	14545 3	13
14	9702 5	10166 1	10646 6	11144 7	11661 3	12197 3	12753 6	13331 3	13931 7	14555 9	14
15	9710 1	10173 9	10654 7	11153 2	11670 1	12206 4	12763 1	13341 2	13941 9	14566 5	15
16	9717 7	10181 8	10662 9	11161 6	11678 9	12215 5	12772 5	13351 0	13952 1	14577 1	16
17	9725 3	10189 7	10671 0	11170 1	11687 6	12224 6	12782 0	13360 8	13962 3	14587 8	17
18	9732 9	10197 6	10679 2	11178 6	11696 4	12233 7	12791 4	13370 7	13972 5	14598 4	18
19	9740 5	10205 5	10687 4	11187 0	11705 2	12242 8	12800 9	13380 5	13982 8	14609 0	19
20	9748 1	10213 4	10695 6	11195 5	11714 0	12252 0	12810 4	13390 3	13993 0	14619 7	20
21	9755 7	10221 2	10703 8	11204 0	11722 8	12261 1	12819 9	13400 2	14003 3	14630 3	21
22	9763 3	10229 1	10712 0	11212 5	11731 6	12270 3	12829 4	13410 1	14013 5	14641 0	22
23	9770 9	10237 1	10720 2	11221 0	11740 4	12279 4	12838 9	13419 9	14023 8	14651 7	23
24	9778 6	10245 0	10728 4	11229 5	11749 3	12288 6	12848 4	13429 8	14034 0	14662 3	24
25	9786 2	10252 9	10736 6	11238 0	11758 1	12297 7	12857 9	13439 7	14044 3	14673 0	25
26	9793 9	10260 8	10744 8	11246 5	11766 9	12306 9	12867 4	13449 6	14054 6	14683 7	26
27	9801 5	10268 7	10753 0	11255 0	11775 8	12316 1	12876 9	13459 5	14064 9	14694 4	27
28	9809 2	10276 7	10761 2	11263 6	11784 6	12325 2	12886 5	13469 4	14075 1	14705 1	28
29	9816 8	10284 6	10769 4	11272 1	11793 4	12334 4	12896 0	13479 3	14085 4	14715 8	29
30	9824 5	10292 5	10777 6	11280 6	11802 3	12343 6	12905 5	13489 2	14095 7	14726 6	30
31	9832 1	10300 5	10785 9	11289 2	11811 2	12352 8	12915 1	13499 1	14106 1	14737 3	31
32	9839 8	10308 4	10794 1	11297 7	11820 0	12362 0	12924 6	13509 0	14116 4	14748 0	32
33	9847 5	10316 4	10802 4	11306 3	11828 9	12371 2	12934 2	13518 9	14126 7	14758 8	33
34	9855 2	10324 3	10810 6	11314 8	11837 8	12380 4	12943 7	13528 9	14137 0	14769 5	34
35	9862 8	10332 3	10818 9	11323 4	11846 6	12389 6	12953 3	13538 8	14147 4	14780 3	35
36	9870 5	10340 3	10827 1	11331 9	11855 5	12398 8	12962 9	13548 8	14157 7	14791 0	36
37	9878 2	10348 2	10835 4	11340 5	11864 4	12408 1	12972 5	13558 7	14168 1	14801 8	37
38	9885 9	10356 2	10843 6	11349 1	11873 3	12417 3	12982 1	13568 7	14178 4	14812 6	38
39	9893 6	10364 2	10851 9	11357 7	11882 2	12426 5	12991 7	13578 7	14188 8	14823 4	39
40	9901 3	10372 2	10860 2	11366 2	11891 1	12435 8	13001 3	13588 6	14199 2	14834 2	40
41	9909 0	10380 2	10868 5	11374 8	11900 0	12445 0	13010 9	13598 6	14209 5	14845 0	41
42	9916 8	10388 2	10876 8	11383 4	11909 0	12454 3	13020 5	13608 6	14219 9	14855 8	42
43	9924 5	10396 2	10885 1	11392 0	11917 9	12463 6	13030 1	13618 6	14230 3	14866 6	43
44	9932 2	10404 2	10893 4	11400 6	11926 8	12472 8	13039 7	13628 6	14240 7	14877 4	44
45	9939 9	10412 2	10901 7	11409 3	11935 7	12482 1	13049 4	13638 6	14251 1	14888 2	45
46	9947 7	10420 2	10910 0	11417 9	11944 7	12491 4	13059 0	13648 6	14261 5	14899 1	46
47	9955 4	10428 2	10918 3	11426 5	11953 6	12500 7	13068 6	13658 7	14272 0	14909 9	47
48	9963 1	10436 2	10926 6	11435 1	11962 6	12510 0	13078 3	13668 7	14282 4	14920 7	48
49	9970 9	10444 3	10935 0	11443 8	11971 5	12519 3	13087 9	13678 7	14292 8	14931 6	49
50	9978 6	10452 3	10943 3	11452 4	11980 5	12528 6	13097 6	13688 8	14303 3	14942 5	50
51	9986 4	10460 3	10951 6	11461 0	11989 5	12537 9	13107 3	13698 8	14313 7	14953 3	51
52	9994 2	10468 4	10960 0	11469 7	11998 4	12547 2	13116 9	13708 9	14324 2	14964 2	52
53	10001 9	10476 4	10968 3	11478 3	12007 4	12556 5	13126 6	13718 9	14334 6	14975 1	53
54	10009 7	10484 5	10976 6	11487 0	12016 4	12565 8	13136 3	13729 0	14345 1	14986 0	54
55	10017 5	10492 5	10985 0	11495 7	12025 4	12575 2	13146 0	13739 1	14355 6	14996 9	55
56	10025 2	10500 6	10993 4	11504 3	12034 4	12584 5	13155 7	13749 1	14366 0	15007 8	56
57	10033 0	10508 7	11001 7	11513 0	12043 4	12593 9	13165 4	13759 2	14376 5	15018 7	57
58	10040 8	10516 7	11010 1	11521 7	12052 4	12603 2	13175 1	13769 3	14387 0	15029 6	58
59	10048 6	10524 8	11018 5	11530 4	12061 4	12612 6	13184 8	13779 4	14397 5	15040 6	59
60	10056 4	10532 9	11026 9	11539 1	12070 4	12621 9	13194 6	13789 5	14408 0	15051 5	60
	50°	51°	52°	53°	54°	55°	56°	57°	58°	59°	
	Latitude or Declination										

′	Latitude or Declination										′
	60°	61°	62°	63°	64°	65°	66°	67°	68°	69°	
0	15051 5	15721 4	16419 5	17147 7	17907 9	18702 6	19534 3	20406 1	21321 2	22283 5	0
1	15062 4	15732 8	16431 4	17160 1	17920 9	18716 1	19548 5	20421 0	21336 9	22300 0	1
2	15073 4	15744 2	16443 3	17172 5	17933 8	18729 7	19562 7	20435 9	21352 5	22316 5	2
3	15084 4	15755 7	16455 2	17184 9	17946 8	18743 3	19576 9	20450 8	21368 2	22333 0	3
4	15095 3	15767 1	16467 1	17197 3	17959 8	18756 9	19591 2	20465 7	21383 9	22349 5	4
5	15106 3	15778 5	16479 0	17209 8	17972 8	18770 5	19605 4	20480 7	21399 6	22366 0	5
6	15117 3	15790 0	16491 0	17222 2	17985 8	18784 1	19619 7	20495 6	21415 3	22382 5	6
7	15128 3	15801 4	16502 9	17234 7	17998 8	18797 7	19633 9	20510 6	21431 0	22399 1	7
8	15139 3	15812 9	16514 8	17247 1	18011 8	18811 3	19648 2	20525 5	21446 7	22415 6	8
9	15150 3	15824 3	16526 8	17259 6	18024 9	18824 9	19662 5	20540 5	21462 5	22432 2	9
10	15161 3	15835 8	16538 8	17272 1	18037 9	18838 6	19676 8	20555 5	21478 2	22448 8	10
11	15172 3	15847 3	16550 7	17284 6	18050 9	18852 2	19691 1	20570 5	21494 0	22465 4	11
12	15183 3	15858 8	16562 7	17297 1	18064 0	18865 9	19705 4	20585 5	21509 8	22482 0	12
13	15194 4	15870 3	16574 7	17309 6	18077 1	18879 6	19719 7	20600 6	21525 6	22498 7	13
14	15205 4	15881 8	16586 7	17322 1	18090 2	18893 2	19734 1	20615 6	21541 4	22515 3	14
15	15216 4	15893 3	16598 7	17334 6	18103 3	18906 9	19748 4	20630 7	21557 2	22532 0	15
16	15227 5	15904 8	16610 7	17347 2	18116 4	18920 6	19762 8	20645 7	21573 1	22548 7	16
17	15238 6	15916 3	16622 7	17359 7	18129 5	18934 4	19777 1	20660 8	21588 9	22565 4	17
18	15249 6	15927 8	16634 7	17372 3	18142 6	18948 1	19791 5	20675 9	21604 8	22582 1	18
19	15260 7	15939 4	16646 8	17384 8	18155 7	18961 8	19805 9	20691 0	21620 7	22598 8	19
20	15271 8	15950 9	16658 8	17397 4	18168 8	18975 6	19820 3	20706 1	21636 6	22615 5	20
21	15282 9	15962 5	16670 9	17410 0	18182 0	18989 3	19834 7	20721 3	21652 5	22632 3	21
22	15294 0	15974 0	16682 9	17422 6	18195 2	19003 1	19849 2	20736 4	21668 4	22649 1	22
23	15305 1	15985 6	16695 0	17435 2	18208 3	19016 9	19863 6	20751 6	21684 3	22665 8	23
24	15316 2	15997 2	16707 1	17447 8	18221 5	19030 7	19878 1	20766 7	21700 3	22682 6	24
25	15327 3	16008 8	16719 2	17460 4	18234 7	19044 5	19892 5	20781 9	21716 2	22699 5	25
26	15338 5	16020 4	16731 3	17473 0	18247 9	19058 3	19907 0	20797 1	21732 2	22716 3	26
27	15349 6	16032 0	16743 4	17485 7	18261 1	19072 1	19921 5	20812 3	21748 2	22733 1	27
28	15360 7	16043 6	16755 5	17498 3	18274 3	19086 0	19936 0	20827 5	21764 2	22750 0	28
29	15371 9	16055 2	16767 6	17511 0	18287 5	19099 8	19950 5	20842 8	21780 2	22766 8	29
30	15383 1	16066 9	16779 7	17523 6	18300 8	19113 7	19965 0	20858 0	21796 2	22783 7	30
31	15394 2	16078 5	16791 9	17536 3	18314 0	19127 5	19979 6	20873 3	21812 3	22800 6	31
32	15405 4	16090 1	16804 0	17549 0	18327 3	19141 4	19994 1	20888 5	21828 3	22817 6	32
33	15416 6	16101 8	16816 2	17561 7	18340 6	19155 3	20008 7	20903 8	21844 4	22834 5	33
34	15427 8	16113 5	16828 3	17574 4	18353 8	19169 2	20023 2	20919 1	21860 5	22851 4	34
35	15439 0	16125 1	16840 5	17587 1	18367 1	19183 1	20037 8	20934 4	21876 6	22868 4	35
36	15450 2	16136 8	16852 7	17599 8	18380 4	19197 0	20052 4	20949 7	21892 7	22885 4	36
37	15461 4	16148 5	16864 9	17612 5	18393 7	19210 9	20067 0	20965 1	21908 8	22902 4	37
38	15472 6	16160 2	16877 1	17625 3	18407 0	19224 9	20081 6	20980 4	21925 0	22919 4	38
39	15483 8	16171 9	16889 3	17638 0	18420 4	19238 8	20096 2	20995 8	21941 1	22936 4	39
40	15495 1	16183 6	16901 5	17650 8	18433 7	19252 8	20110 9	21011 1	21957 3	22953 4	40
41	15506 3	16195 3	16913 7	17663 6	18447 1	19266 8	20125 5	21026 5	21973 5	22970 5	41
42	15517 6	16207 0	16926 0	17676 3	18460 4	19280 8	20140 2	21041 9	21989 7	22987 6	42
43	15528 8	16218 8	16938 2	17689 1	18473 8	19294 8	20154 9	21057 3	22005 9	23004 6	43
44	15540 1	16230 5	16950 4	17701 9	18487 2	19308 8	20169 5	21072 8	22022 1	23021 7	44
45	15551 4	16242 3	16962 7	17714 7	18500 6	19322 8	20184 2	21088 2	22038 3	23038 8	45
46	15562 7	16254 0	16975 0	17727 5	18514 0	19336 8	20198 9	21103 6	22054 6	23056 0	46
47	15574 0	16265 8	16987 2	17740 3	18527 4	19350 8	20213 7	21119 1	22070 8	23073 1	47
48	15585 3	16277 6	16999 5	17753 2	18540 8	19364 9	20228 4	21134 6	22087 1	23090 3	48
49	15596 6	16289 4	17011 8	17766 0	18554 2	19378 9	20243 1	21150 0	22103 4	23107 5	49
50	15607 9	16301 2	17024 1	17778 9	18567 6	19393 0	20257 9	21165 5	22119 7	23124 7	50
51	15619 2	16313 0	17036 5	17791 7	18581 1	19407 1	20272 7	21181 0	22136 0	23141 9	51
52	15630 5	16324 8	17048 8	17804 6	18594 6	19421 2	20287 4	21196 6	22152 4	23159 1	52
53	15641 9	16336 6	17061 1	17817 5	18608 0	19435 3	20302 2	21212 1	22168 7	23176 3	53
54	15653 2	16348 4	17073 4	17830 4	18621 5	19449 4	20317 0	21227 7	22185 1	23193 6	54
55	15664 6	16360 2	17085 8	17843 3	18635 0	19463 5	20331 8	21243 2	22201 4	23210 8	55
56	15675 9	16372 1	17098 1	17856 2	18648 5	19477 7	20346 7	21258 8	22217 8	23228 1	56
57	15687 3	16383 9	17110 5	17869 1	18662 0	19491 8	20361 5	21274 4	22234 2	23245 4	57
58	15698 7	16395 8	17122 9	17882 0	18675 5	19506 0	20376 4	21290 0	22250 7	23262 7	58
59	15710 0	16407 7	17135 3	17895 0	18689 0	19520 2	20391 2	21305 6	22267 1	23280 1	59
60	15721 4	16419 5	17147 7	17907 9	18702 6	19534 3	20406 1	21321 2	22283 5	23297 4	60
	60°	61°	62°	63°	64°	65°	66°	67°	68°	69°	
	Latitude or Declination										

′	Latitude or Declination										′
	70°	71°	72°	73°	74°	75°	76°	77°	78°	79°	
0	23297 4	24367 9	25500 9	26703 2	27983 1	29350 2	30816 2	32395 6	34106 1	35970 1	0
1	23314 8	24386 3	25520 3	26723 9	28005 1	29373 8	30841 6	32423 0	34135 8	36002 6	1
2	23332 2	24404 6	25539 8	26744 6	28027 2	29397 4	30867 0	32450 4	34165 6	36035 2	2
3	23349 6	24423 0	25559 3	26765 3	28049 3	29421 0	30892 4	32477 8	34195 4	36067 8	3
4	23367 0	24441 4	25578 8	26786 0	28071 4	29444 7	30917 8	32505 3	34225 3	36100 5	4
5	23384 4	24459 8	25598 3	26806 8	28093 5	29468 4	30943 3	32532 8	34255 2	36133 2	5
6	23401 8	24478 3	25617 9	26827 6	28115 7	29492 1	30968 8	32560 4	34285 1	36166 0	6
7	23419 3	24496 7	25637 4	26848 4	28137 9	29515 9	30994 4	32588 0	34315 1	36198 8	7
8	23436 8	24515 2	25657 0	26869 2	28160 1	29539 7	31020 0	32615 6	34345 2	36231 7	8
9	23454 2	24533 7	25676 6	26890 1	28182 3	29563 5	31045 6	32643 3	34375 3	36264 6	9
10	23471 8	24552 2	25696 3	26910 9	28204 6	29587 3	31071 2	32671 0	34405 4	36297 6	10
11	23489 3	24570 8	25715 9	26931 8	28226 9	29611 2	31096 9	32698 8	34435 6	36330 6	11
12	23506 8	24589 3	25735 6	26952 7	28249 2	29635 1	31122 6	32726 6	34465 8	36363 7	12
13	23524 4	24607 9	25755 3	26973 6	28271 5	29659 0	31148 3	32754 4	34496 0	36396 8	13
14	23541 9	24626 4	25775 0	26994 6	28293 9	29682 9	31174 1	32782 3	34526 3	36430 0	14
15	23559 5	24645 0	25794 7	27015 6	28316 3	29706 9	31199 9	32810 2	34556 7	36463 3	15
16	23577 1	24663 7	25814 4	27036 6	28338 7	29730 9	31225 7	32838 1	34587 1	36496 6	16
17	23594 7	24682 3	25834 2	27057 6	28361 1	29755 0	31251 5	32866 1	34617 5	36529 9	17
18	23612 4	24700 9	25854 0	27078 6	28383 6	29779 0	31277 4	32894 1	34648 0	36563 3	18
19	23630 0	24719 6	25873 8	27099 7	28406 1	29803 1	31303 3	32922 1	34678 5	36596 8	19
20	23647 7	24738 3	25893 6	27120 8	28428 6	29827 2	31329 3	32950 2	34709 1	36630 3	20
21	23665 4	24757 0	25913 4	27141 9	28451 1	29851 4	31355 3	32978 3	34739 7	36663 9	21
22	23683 1	24775 7	25933 3	27163 0	28473 7	29875 6	31381 3	33006 5	34770 3	36697 5	22
23	23700 8	24794 5	25953 2	27184 2	28496 3	29899 8	31407 4	33034 7	34801 0	36731 2	23
24	23718 5	24813 2	25973 1	27205 4	28518 9	29924 0	31433 5	33062 9	34831 8	36764 9	24
25	23736 3	24832 0	25993 0	27226 6	28541 5	29948 3	31459 6	33091 2	34862 6	36798 7	25
26	23754 0	24850 8	26012 9	27247 8	28564 2	29972 6	31485 8	33119 5	34893 4	36832 5	26
27	23771 8	24869 6	26032 9	27269 0	28586 9	29996 9	31512 0	33147 9	34924 3	36866 4	27
28	23789 6	24888 5	26052 9	27290 3	28609 6	30021 2	31538 2	33176 3	34955 2	36900 3	28
29	23807 4	24907 3	26072 9	27311 6	28632 3	30045 6	31564 5	33204 7	34986 2	36934 3	29
30	23825 2	24926 2	26092 9	27332 9	28655 1	30070 0	31590 8	33233 2	35017 2	36968 4	30
31	23843 1	24945 1	26113 0	27354 2	28677 9	30094 5	31617 1	33261 7	35048 3	37002 5	31
32	23861 0	24964 0	26133 0	27375 6	28700 7	30118 9	31643 4	33290 2	35079 4	37036 6	32
33	23878 8	24982 9	26153 1	27397 0	28723 5	30143 4	31669 8	33318 8	35110 6	37070 8	33
34	23896 7	25001 8	26173 2	27418 4	28746 4	30167 9	31696 2	33347 4	35141 8	37105 1	34
35	23914 6	25020 8	26193 3	27439 8	28769 3	30192 5	31722 7	33376 1	35173 1	37139 4	35
36	23932 6	25039 8	26213 5	27461 3	28792 2	30217 1	31749 2	33404 8	35204 4	37173 8	36
37	23950 5	25058 8	26233 7	27482 8	28815 1	30241 7	31775 7	33433 6	35235 7	37208 3	37
38	23968 5	25077 8	26253 9	27504 3	28838 1	30266 4	31802 3	33462 4	35267 1	37242 8	38
39	23986 4	25096 8	26274 1	27525 8	28861 1	30291 1	31828 9	33491 2	35298 5	37277 4	39
40	24004 4	25115 9	26294 3	27547 3	28884 1	30315 8	31855 5	33520 1	35330 0	37312 0	40
41	24022 5	25135 0	26314 5	27568 9	28907 2	30340 5	31882 2	33549 0	35361 6	37346 7	41
42	24040 5	25154 1	26334 8	27590 5	28930 3	30365 3	31908 9	33577 9	35393 2	37381 4	42
43	24058 5	25173 2	26355 1	27612 1	28953 4	30390 1	31935 6	33606 9	35424 8	37416 2	43
44	24076 6	25192 3	26375 4	27633 7	28976 5	30414 9	31962 4	33635 9	35456 5	37451 0	44
45	24094 7	25211 4	26395 7	27655 4	28999 6	30439 7	31989 2	33665 0	35488 2	37485 9	45
46	24112 8	25230 6	26416 1	27677 1	29022 8	30464 6	32016 1	33694 1	35520 0	37520 9	46
47	24130 9	25249 8	26436 5	27698 8	29046 0	30489 5	32043 0	33723 3	35551 8	37555 9	47
48	24149 0	25269 0	26456 9	27720 5	29069 3	30514 5	32069 9	33752 5	35583 7	37591 0	48
49	24167 2	25288 2	26477 3	27742 2	29092 5	30539 5	32096 8	33781 7	35615 6	37626 1	49
										Polaris	
50	24185 3	25307 4	26497 7	27764 0	29115 8	30564 5	32123 8	33811 0	35647 6	88°	50
51	24203 5	25326 7	26518 2	27785 8	29139 1	30589 5	32150 8	33840 3	35679 6	84872 7	51
52	24221 7	25346 0	26538 7	27807 6	29162 5	30614 6	32177 9	33869 7	35711 7	85189 7	52
53	24239 9	25365 3	26559 2	27829 5	29185 9	30639 7	32205 0	33899 1	35743 8	85511 3	53
54	24258 1	25384 6	26579 7	27851 4	29209 3	30664 8	32232 1	33928 5	35776 0	85837 8	54
55	24276 4	25403 9	26600 2	27873 3	29232 7	30690 0	32259 3	33958 0	35808 2	86169 3	55
56	24294 7	25423 3	26620 8	27895 2	29256 1	30715 2	32286 5	33987 5	35840 5	86506 0	56
57	24313 0	25442 6	26641 4	27917 1	29279 6	30740 4	32313 7	34017 1	35872 8	86847 9	57
58	24331 3	25462 0	26662 0	27939 1	29303 1	30765 6	32341 0	34046 7	35905 2	87195 3	58
59	24349 6	25481 4	26682 6	27961 1	29326 6	30790 9	32368 3	34076 4	35937 6	87548 3	59
60	24367 9	25500 9	26703 2	27983 1	29350 2	30816 2	32395 6	34106 1	35970 1	87907 2	60
	70°	71°	72°	73°	74°	75°	76°	77°	78°	79°	

Latitude or Declination

′	0°		1°		2°		3°		4°		
	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	
0	0 0	∞	15 2	205915 8	60 9	175814 5	137 0	158208 1	243 6	145718 1	60
1	0 0	383730 4	15 7	205198 0	61 9	175454 1	138 6	157967 5	245 6	145537 6	59
2	0 0	353627 4	16 3	204491 8	63 0	175096 7	140 1	157728 3	247 7	145357 8	58
3	0 0	336018 3	16 8	203796 9	64 0	174742 2	141 6	157490 4	249 7	145178 8	57
4	0 1	323524 4	17 3	203113 0	65 0	174390 6	143 2	157253 8	251 8	145000 5	56
5	0 1	313833 4	17 9	202439 7	66 1	174041 8	144 8	157018 5	253 8	144823 0	55
6	0 1	305915 3	18 4	201776 7	67 2	173695 8	146 3	156784 4	255 9	144646 1	54
7	0 2	299220 6	19 0	201123 6	68 2	173352 5	147 9	156551 6	258 0	144470 0	53
8	0 3	293421 4	19 6	200480 2	69 3	173011 9	149 5	156320 0	260 1	144294 6	52
9	0 3	288306 1	20 1	199846 2	70 4	172674 0	151 1	156089 7	262 2	144119 9	51
10	0 4	283730 4	20 7	199221 3	71 5	172338 6	152 7	155860 6	264 3	143946 0	50
11	0 5	279591 1	21 3	198605 3	72 6	172005 9	154 3	155632 6	266 4	143772 7	49
12	0 6	275812 3	21 9	197997 9	73 7	171675 7	155 9	155405 9	268 5	143600 1	48
13	0 7	272336 1	22 6	197398 9	74 8	171347 9	157 5	155180 4	270 7	143428 1	47
14	0 8	269117 6	23 2	196808 1	76 0	171022 7	159 2	154956 0	272 8	143256 9	46
15	0 9	266121 3	23 8	196225 1	77 1	170699 8	160 8	154732 7	275 0	143086 3	45
16	1 1	263318 4	24 4	195649 9	78 2	170379 3	162 5	154510 7	277 1	142916 4	44
17	1 2	260685 5	25 1	195082 2	79 4	170061 2	164 1	154289 7	279 3	142747 2	43
18	1 4	258203 2	25 7	194521 9	80 6	169745 4	165 8	154069 9	281 5	142578 6	42
19	1 5	255855 1	26 4	193968 6	81 7	169431 9	167 5	153851 1	283 7	142410 7	41
20	1 7	253627 5	27 1	193422 4	82 9	169120 6	169 2	153633 5	285 9	142243 4	40
21	1 9	251508 5	27 8	192882 9	84 1	168811 5	170 9	153417 0	288 1	142076 8	39
22	2 0	249488 2	28 4	192350 0	85 3	168504 6	172 6	153201 5	290 3	141910 8	38
23	2 2	247557 7	29 1	191823 6	86 5	168199 9	174 3	152987 1	292 5	141745 4	37
24	2 4	245709 4	29 9	191303 5	87 7	167897 3	176 0	152773 7	294 7	141580 7	36
25	2 6	243936 5	30 6	190789 6	88 9	167596 8	177 7	152561 4	297 0	141416 6	35
26	2 9	242233 2	31 3	190281 7	90 2	167298 4	179 5	152350 2	299 2	141253 1	34
27	3 1	240594 1	32 0	189779 6	91 4	167002 0	181 2	152139 9	301 5	141090 2	33
28	3 3	239014 7	32 8	189283 3	92 7	166707 6	183 0	151930 7	303 7	140927 9	32
29	3 6	237490 7	33 5	188792 6	93 9	166415 2	184 7	151722 4	306 0	140766 2	31
30	3 8	236018 4	34 3	188307 4	95 2	166124 7	186 5	151515 2	308 3	140605 2	30
31	4 1	234594 4	35 0	187827 5	96 4	165836 2	188 3	151309 0	310 5	140444 7	29
32	4 3	233215 5	35 8	187352 9	97 7	165549 6	190 1	151103 7	312 8	140284 8	28
33	4 6	231879 2	36 6	186883 4	99 0	165264 8	191 9	150899 4	315 1	140125 5	27
34	4 9	230582 7	37 4	186419 0	100 3	164981 9	193 7	150696 0	317 5	139966 8	26
35	5 2	229323 8	38 2	185959 4	101 6	164700 9	195 5	150493 6	319 8	139808 7	25
36	5 5	228100 3	39 0	185504 7	102 9	164421 7	197 3	150292 2	322 1	139651 1	24
37	5 8	226910 4	39 8	185054 7	104 3	164144 2	199 2	150091 6	324 4	139494 2	23
38	6 1	225752 2	40 6	184609 3	105 6	163868 5	201 0	149892 0	326 8	139337 7	22
39	6 4	224624 2	41 5	184168 4	106 9	163594 5	202 8	149693 3	329 1	139181 9	21
40	6 8	223524 6	42 3	183731 9	108 3	163322 3	204 7	149495 5	331 5	139026 6	20
41	7 1	222452 3	43 2	183299 8	109 6	163051 8	206 6	149298 6	333 9	138871 8	19
42	7 5	221405 7	44 0	182872 0	111 0	162782 9	208 4	149102 6	336 3	138717 7	18
43	7 8	220383 8	44 9	182448 3	112 4	162515 7	210 3	148907 5	338 6	138564 0	17
44	8 2	219385 4	45 8	182028 7	113 8	162250 1	212 2	148713 3	341 0	138410 9	16
45	8 6	218409 4	46 6	181613 1	115 2	161986 2	214 1	148519 9	343 4	138258 3	15
46	8 9	217454 9	47 5	181201 5	116 6	161723 8	216 0	148327 4	345 9	138106 3	14
47	9 3	216520 9	48 4	180793 8	118 0	161463 0	217 9	148135 7	348 3	137954 8	13
48	9 7	215606 6	49 3	180389 8	119 4	161203 8	219 8	147944 9	350 7	137803 8	12
49	10 2	214711 1	50 3	179989 6	120 8	160946 1	221 8	147754 9	353 1	137653 4	11
50	10 6	213833 8	51 2	179593 0	122 2	160689 9	223 7	147565 7	355 6	137503 5	10
51	11 0	212973 8	52 1	179200 0	123 7	160435 2	225 7	147377 4	358 0	137354 1	9
52	11 4	212130 5	53 1	178810 5	125 1	160182 1	227 6	147189 8	360 5	137205 2	8
53	11 9	211303 2	54 0	178424 5	126 6	159930 4	229 6	147003 1	363 0	137056 8	7
54	12 3	210491 5	55 0	178041 9	128 1	159680 1	231 6	146817 2	365 5	136908 9	6
55	12 8	209694 6	55 9	177662 6	129 5	159431 3	233 5	146632 1	368 0	136761 5	5
56	13 3	208912 1	56 9	177286 6	131 0	159183 9	235 5	146447 7	370 5	136614 6	4
57	13 7	208143 4	57 9	176913 9	132 5	158937 9	237 5	146264 2	373 0	136468 3	3
58	14 2	207388 1	58 9	176544 3	134 0	158693 2	239 5	146081 4	375 5	136322 4	2
59	14 7	206645 7	59 9	176177 9	135 5	158450 0	241 6	145899 3	378 0	136177 0	1
60	15 2	205915 8	60 9	175814 5	137 0	158208 1	243 6	145718 1	380 5	136032 0	0
	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	′
	89°	359°	88°	358°	87°	357°	86°	356°	85°	355°	

′	5°		6°		7°		8°		9°		
	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	
0	380 5	136032 0	547 8	128120 0	745 4	121432 5	973 2	115641 5	1231 2	110535 7	60
1	383 1	135887 6	550 9	127999 6	748 9	121329 3	977 2	115551 3	1235 7	110455 5	59
2	385 6	135743 7	553 9	127879 6	752 5	121226 4	981 3	115461 3	1240 3	110375 4	58
3	388 2	135600 2	557 0	127759 9	756 1	121123 8	985 4	115371 4	1244 9	110295 6	57
4	390 7	135457 2	560 0	127640 5	759 6	121021 3	989 4	115281 7	1249 4	110215 8	56
5	393 3	135314 6	563 1	127521 5	763 2	120919 2	993 5	115192 2	1254 0	110136 2	55
6	395 9	135172 6	566 2	127402 8	766 8	120817 2	997 6	115102 9	1258 6	110056 8	54
7	398 5	135031 0	569 3	127284 4	770 4	120715 5	1001 7	115013 8	1263 2	109977 5	53
8	401 1	134889 8	572 4	127166 3	774 0	120614 1	1005 8	114924 9	1267 8	109898 3	52
9	403 7	134749 2	575 5	127048 6	777 6	120512 8	1010 0	114836 1	1272 5	109819 3	51
10	406 3	134608 9	578 6	126931 2	781 3	120411 9	1014 1	114747 5	1277 1	109740 4	50
11	408 9	134469 2	581 8	126814 1	784 9	120311 1	1018 2	114659 2	1281 7	109661 7	49
12	411 6	134329 8	584 9	126697 3	788 5	120210 6	1022 4	114570 9	1286 4	109583 1	48
13	414 2	134191 0	588 0	126580 8	792 2	120110 3	1026 5	114482 9	1291 0	109504 7	47
14	416 8	134052 5	591 2	126464 6	795 8	120010 3	1030 7	114395 1	1295 7	109426 4	46
15	419 5	133914 5	594 4	126348 8	799 5	119910 4	1034 9	114307 4	1300 4	109348 3	45
16	422 2	133777 0	597 5	126233 3	803 2	119810 8	1039 0	114219 9	1305 0	109270 3	44
17	424 8	133639 8	600 7	126118 0	806 9	119711 5	1043 2	114132 6	1309 7	109192 4	43
18	427 5	133503 2	603 9	126003 1	810 6	119612 4	1047 4	114045 4	1314 4	109114 7	42
19	430 2	133366 9	607 1	125888 5	814 3	119513 4	1051 6	113958 5	1319 1	109037 1	41
20	432 9	133231 1	610 3	125774 1	818 0	119414 8	1055 8	113871 7	1323 8	108959 6	40
21	435 6	133095 7	613 5	125660 1	821 7	119316 3	1060 1	113785 1	1328 6	108882 3	39
22	438 3	132960 7	616 7	125546 4	825 4	119218 1	1064 3	113698 6	1333 3	108805 1	38
23	441 1	132826 1	620 0	125433 0	829 1	119120 1	1068 5	113612 3	1338 0	108728 1	37
24	443 8	132692 0	623 2	125319 8	832 9	119022 3	1072 8	113526 2	1342 8	108651 2	36
25	446 5	132558 2	626 4	125207 0	836 6	118924 7	1077 0	113440 3	1347 5	108574 4	35
26	449 3	132424 9	629 7	125094 5	840 4	118827 4	1081 3	113354 5	1352 3	108497 8	34
27	452 0	132292 0	633 0	124982 2	844 2	118730 2	1085 5	113269 0	1357 1	108421 3	33
28	454 8	132159 5	636 2	124870 3	847 9	118633 3	1089 8	113183 5	1361 8	108345 0	32
29	457 6	132027 4	639 5	124758 6	851 7	118536 6	1094 1	113098 3	1366 6	108268 7	31
30	460 4	131895 7	642 8	124647 2	855 5	118440 1	1098 4	113013 2	1371 4	108192 7	30
31	463 2	131764 4	646 1	124536 1	859 3	118343 9	1102 7	112928 3	1376 2	108116 7	29
32	466 0	131633 5	649 4	124425 3	863 1	118247 8	1107 0	112843 5	1381 1	108040 9	28
33	468 8	131502 9	652 7	124314 8	866 9	118152 0	1111 3	112759 0	1385 9	107965 2	27
34	471 6	131372 8	656 0	124204 5	870 8	118056 4	1115 7	112674 5	1390 7	107889 7	26
35	474 4	131243 1	659 4	124094 6	874 6	117961 0	1120 0	112590 3	1395 5	107814 2	25
36	477 3	131113 7	662 7	123984 9	878 4	117865 7	1124 4	112506 2	1400 4	107739 0	24
37	480 1	130984 8	666 1	123875 5	882 3	117770 8	1128 7	112422 3	1405 2	107663 8	23
38	482 9	130856 2	669 4	123766 3	886 2	117676 0	1133 1	112338 5	1410 1	107588 8	22
39	485 8	130728 0	672 8	123657 5	890 0	117581 4	1137 4	112254 9	1415 0	107513 9	21
40	488 7	130600 2	676 2	123548 9	893 9	117487 0	1141 8	112171 5	1419 9	107439 1	20
41	491 6	130472 8	679 5	123440 6	897 8	117392 8	1146 2	112088 2	1424 8	107364 5	19
42	494 4	130345 7	682 9	123332 5	901 7	117298 9	1150 6	112005 1	1429 6	107290 0	18
43	497 3	130219 0	686 3	123224 8	905 6	117205 1	1155 0	111922 1	1434 6	107215 6	17
44	500 2	130092 7	689 7	123117 2	909 5	117111 6	1159 4	111839 3	1439 5	107141 3	16
45	503 1	129966 7	693 1	123010 0	913 4	117018 2	1163 8	111756 7	1444 4	107067 2	15
46	506 1	129841 1	696 6	122903 0	917 3	116925 1	1168 3	111674 2	1449 3	106993 2	14
47	509 0	129715 9	700 0	122796 3	921 3	116832 1	1172 7	111591 9	1454 3	106919 4	13
48	511 9	129591 0	703 4	122689 9	925 2	116739 3	1177 2	111509 7	1459 2	106845 6	12
49	514 9	129466 5	706 9	122583 7	929 2	116646 8	1181 6	111427 7	1464 2	106772 0	11
50	517 8	129342 3	710 3	122477 7	933 1	116554 4	1186 1	111345 8	1469 1	106698 5	10
51	520 8	129218 5	713 8	122372 1	937 1	116462 3	1190 5	111264 1	1474 1	106625 1	9
52	523 7	129095 1	717 3	122266 7	941 1	116370 3	1195 0	111182 6	1479 1	106551 9	8
53	526 7	128972 0	720 8	122161 5	945 1	116278 5	1199 5	111101 2	1484 1	106478 8	7
54	529 7	128849 3	724 3	122056 6	949 0	116187 0	1204 0	111019 9	1489 1	106405 8	6
55	532 7	128726 8	727 8	121952 0	953 1	116095 6	1208 5	110938 8	1494 1	106332 9	5
56	535 7	128604 8	731 3	121847 6	957 1	116004 4	1213 0	110857 9	1499 1	106260 2	4
57	538 7	128483 1	734 8	121743 4	961 1	115913 4	1217 5	110777 1	1504 1	106187 5	3
58	541 7	128361 7	738 3	121639 5	965 1	115822 6	1222 1	110696 5	1509 1	106115 0	2
59	544 8	128240 6	741 8	121535 9	969 1	115732 0	1226 6	110616 0	1514 2	106042 7	1
60	547 8	128120 0	745 4	121432 5	973 2	115641 5	1231 2	110535 7	1519 2	105970 4	0
	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	′
	84°	354°	83°	353°	82°	352°	81°	351°	80°	350°	

′	10°		11°		12°		13°		14°		
	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	
0	1519 2	105970 4	1837 3	101842 7	2185 2	98076 5	2563 0	94614 1	2970 4	91410 6	60
1	1524 3	105898 3	1842 8	101777 2	2191 3	98016 5	2569 5	94558 7	2977 5	91359 1	59
2	1529 3	105826 2	1848 4	101711 7	2197 3	97956 5	2576 1	94503 4	2984 5	91307 8	58
3	1534 4	105754 3	1854 0	101646 4	2203 4	97896 6	2582 7	94448 1	2991 6	91256 5	57
4	1539 5	105682 6	1859 5	101581 1	2209 5	97836 8	2589 2	94392 9	2998 6	91205 3	56
5	1544 6	105610 9	1865 1	101516 0	2215 6	97777 1	2595 8	94337 8	3005 7	91154 1	55
6	1549 7	105539 4	1870 7	101450 9	2221 7	97717 5	2602 4	94282 8	3012 8	91103 0	54
7	1554 8	105467 9	1876 3	101385 9	2227 8	97657 9	2609 0	94227 8	3019 9	91052 0	53
8	1559 9	105396 6	1881 9	101321 1	2233 9	97598 4	2615 6	94172 9	3027 0	91001 0	52
9	1565 0	105325 5	1887 6	101256 3	2240 0	97539 0	2622 2	94118 0	3034 1	90950 0	51
10	1570 1	105254 4	1893 2	101191 7	2246 1	97479 7	2628 8	94063 3	3041 2	90899 2	50
11	1575 3	105183 4	1898 8	101127 1	2252 3	97420 5	2635 5	94008 6	3048 3	90848 4	49
12	1580 4	105112 6	1904 5	101062 6	2258 4	97361 4	2642 1	93954 0	3055 5	90797 6	48
13	1585 6	105041 9	1910 1	100998 3	2264 6	97302 3	2648 8	93899 4	3062 6	90747 0	47
14	1590 8	104971 3	1915 8	100934 0	2270 7	97243 3	2655 4	93844 9	3069 7	90696 3	46
15	1595 9	104900 8	1921 5	100869 8	2276 9	97184 4	2662 1	93790 5	3076 9	90645 8	45
16	1601 1	104830 4	1927 1	100805 7	2283 1	97125 6	2668 7	93736 1	3084 1	90595 3	44
17	1606 3	104760 2	1932 8	100741 7	2289 2	97066 8	2675 4	93681 9	3091 2	90544 8	43
18	1611 5	104690 0	1938 5	100677 8	2295 4	97008 2	2685 1	93627 6	3098 4	90494 4	42
19	1616 7	104620 0	1944 2	100614 0	2301 6	96949 6	2688 8	93573 5	3105 6	90444 1	41
20	1621 9	104550 1	1949 9	100550 3	2307 8	96891 1	2695 5	93519 4	3112 8	90393 8	40
21	1627 1	104480 3	1955 7	100486 7	2314 1	96832 7	2702 2	93465 4	3120 0	90343 6	39
22	1632 4	104410 6	1961 4	100423 2	2320 3	96774 3	2708 9	93411 5	3127 2	90293 5	38
23	1637 6	104341 0	1967 1	100359 8	2326 5	96716 1	2715 7	93357 6	3134 4	90243 4	37
24	1642 8	104271 6	1972 9	100296 4	2332 8	96657 9	2722 4	93303 8	3141 7	90193 4	36
25	1648 1	104202 2	1978 6	100233 2	2339 0	96599 8	2729 2	93250 1	3148 9	90143 4	35
26	1653 4	104133 0	1984 4	100170 1	2345 3	96541 8	2735 9	93196 4	3156 2	90093 5	34
27	1658 6	104063 8	1990 2	100107 0	2351 5	96483 8	2742 7	93142 8	3163 4	90043 6	33
28	1663 9	103994 8	1995 9	100044 0	2357 8	96425 9	2749 4	93089 3	3170 7	89993 8	32
29	1669 2	103925 9	2001 7	99981 2	2364 1	96368 1	2756 2	93035 8	3178 0	89944 1	31
30	1674 5	103857 1	2007 5	99918 4	2370 4	96310 4	2763 0	92982 4	3185 2	89894 4	30
31	1679 8	103788 4	2013 3	99855 7	2376 7	96252 8	2769 8	92929 1	3192 5	89844 8	29
32	1685 1	103719 9	2019 1	99793 1	2383 0	96195 2	2776 6	92875 8	3199 8	89795 2	28
33	1690 4	103651 4	2025 0	99730 6	2389 3	96137 7	2783 4	92822 6	3207 1	89745 7	27
34	1695 8	103583 0	2030 8	99668 2	2395 6	96080 3	2790 2	92769 4	3214 4	89696 3	26
35	1701 1	103514 8	2036 6	99605 9	2402 0	96023 0	2797 1	92716 4	3221 7	89646 9	25
36	1706 5	103446 6	2042 5	99543 7	2408 3	95965 8	2803 9	92663 4	3229 1	89597 5	24
37	1711 8	103378 6	2048 3	99481 5	2414 7	95908 6	2810 7	92610 4	3236 4	89548 3	23
38	1717 2	103310 7	2054 2	99419 5	2421 0	95851 5	2817 6	92557 6	3243 8	89499 0	22
39	1722 6	103242 8	2060 1	99357 5	2427 4	95794 5	2824 5	92504 7	3251 1	89449 9	21
40	1727 9	103175 1	2065 9	99295 6	2433 8	95737 5	2831 3	92452 0	3258 5	89400 8	20
41	1733 3	103107 5	2071 8	99233 9	2440 1	95680 6	2838 2	92399 3	3265 8	89351 7	19
42	1738 7	103040 0	2077 7	99172 2	2446 5	95623 8	2845 1	92346 7	3273 2	89302 7	18
43	1744 1	102972 6	2083 6	99110 6	2452 9	95567 1	2852 0	92294 2	3280 6	89253 8	17
44	1749 5	102905 3	2089 5	99049 0	2459 3	95510 5	2858 9	92241 7	3288 0	89204 9	16
45	1755 0	102838 1	2095 4	98987 6	2465 8	95453 9	2865 8	92189 3	3295 4	89156 1	15
46	1760 4	102771 1	2101 4	98926 3	2472 2	95397 4	2872 7	92136 9	3302 8	89107 3	14
47	1765 8	102704 1	2107 3	98865 0	2478 6	95341 0	2879 6	92084 6	3310 2	89058 6	13
48	1771 3	102637 2	2113 3	98803 8	2485 1	95284 6	2886 6	92032 4	3317 7	89009 9	12
49	1776 7	102570 4	2119 2	98742 8	2491 5	95228 3	2893 5	91980 2	3325 1	88961 3	11
50	1782 2	102503 8	2125 2	98681 8	2498 0	95172 1	2900 5	91928 1	3332 5	88912 7	10
51	1787 7	102437 2	2131 1	98620 9	2504 4	95116 0	2907 4	91876 1	3340 0	88864 2	9
52	1793 1	102370 7	2137 1	98560 0	2510 9	95060 0	2914 4	91824 1	3347 4	88815 8	8
53	1798 6	102304 4	2143 1	98499 3	2517 4	95004 0	2921 4	91772 2	3354 9	88767 4	7
54	1804 1	102238 1	2149 1	98438 7	2523 9	94948 1	2928 3	91720 3	3362 4	88719 1	6
55	1809 6	102172 0	2155 1	98378 1	2530 4	94892 2	2935 3	91668 5	3369 9	88670 8	5
56	1815 1	102105 9	2161 1	98317 6	2536 9	94836 5	2942 3	91616 8	3377 4	88622 6	4
57	1820 7	102040 0	2167 1	98257 2	2543 4	94780 8	2949 3	91565 2	3384 9	88574 4	3
58	1826 2	101974 1	2173 2	98196 9	2549 9	94725 1	2956 4	91513 6	3392 4	88526 3	2
59	1831 7	101908 4	2179 2	98136 7	2556 4	94669 6	2963 4	91462 0	3399 9	88478 2	1
60	1837 3	101842 7	2185 2	98076 5	2563 0	94614 1	2970 4	91410 6	3407 4	88430 2	0
	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	′
	79°	349°	78°	348°	77°	347°	76°	346°	75°	345°	

′	15° Sum or Diff.	15° Hour Angle	16° Sum or Diff.	16° Hour Angle	17° Sum or Diff.	17° Hour Angle	18° Sum or Diff.	18° Hour Angle	19° Sum or Diff.	19° Hour Angle	′
0	3407 4	88430 2	3873 8	85644 5	4369 5	83029 8	4894 3	80566 8	5448 1	78239 1	60
1	3414 9	88382 3	3881 8	85599 5	4378 0	82987 5	4903 3	80526 9	5457 6	78201 3	59
2	3422 5	88334 4	3889 9	85554 7	4386 5	82945 3	4912 3	80487 1	5467 1	78163 7	58
3	3430 0	88286 5	3897 9	85509 8	4395 1	82903 2	4921 3	80447 3	5476 6	78126 0	57
4	3437 6	88238 7	3906 0	85465 1	4403 6	82861 1	4930 4	80407 5	5486 1	78088 4	56
5	3445 2	88191 0	3914 0	85420 3	4412 1	82819 0	4939 4	80367 8	5495 6	78050 8	55
6	3452 7	88143 3	3922 1	85375 7	4420 7	82777 0	4948 4	80328 1	5505 1	78013 2	54
7	3460 3	88095 7	3930 2	85331 0	4429 3	82735 0	4957 5	80288 5	5514 6	77975 7	53
8	3467 9	88048 1	3938 2	85286 4	4437 8	82693 0	4966 5	80248 9	5524 2	77938 2	52
9	3475 5	88000 6	3946 3	85241 9	4446 4	82651 1	4975 6	80209 3	5533 7	77900 7	51
10	3483 1	87953 1	3954 4	85197 4	4455 0	82609 2	4984 6	80169 8	5543 2	77863 3	50
11	3490 7	87905 7	3962 5	85152 9	4463 6	82567 4	4993 7	80130 3	5552 8	77825 9	49
12	3498 3	87858 3	3970 6	85108 5	4472 2	82525 6	5002 8	80090 9	5562 4	77788 5	48
13	3506 0	87811 0	3978 7	85064 2	4480 8	82483 9	5011 9	80051 4	5571 9	77751 2	47
14	3513 6	87763 8	3986 9	85019 8	4489 4	82442 2	5021 0	80012 1	5581 5	77713 9	46
15	3521 3	87716 5	3995 0	84975 6	4498 0	82400 5	5030 1	79972 7	5591 1	77676 6	45
16	3528 9	87669 4	4003 2	84931 4	4506 6	82358 9	5039 2	79933 4	5600 7	77639 4	44
17	3536 6	87622 3	4011 3	84887 2	4515 3	82317 3	5048 3	79894 1	5610 3	77602 2	43
18	3544 3	87575 2	4019 5	84843 1	4523 9	82275 8	5057 4	79854 9	5619 9	77565 1	42
19	3551 9	87528 2	4027 6	84799 0	4532 6	82234 3	5066 6	79815 7	5629 5	77527 9	41
20	3559 6	87481 3	4035 8	84754 9	4541 2	82192 8	5075 7	79776 6	5639 1	77490 8	40
21	3567 3	87434 4	4044 0	84710 9	4549 9	82151 4	5084 9	79737 4	5648 8	77453 8	39
22	3575 0	87387 5	4052 2	84667 0	4558 6	82110 0	5094 0	79698 3	5658 4	77416 7	38
23	3582 7	87340 7	4060 4	84623 1	4567 3	82068 7	5103 2	79659 3	5668 1	77379 7	37
24	3590 5	87294 0	4068 6	84579 2	4576 0	82027 4	5112 4	79620 3	5677 7	77342 7	36
25	3598 2	87247 3	4076 8	84535 4	4584 7	81986 1	5121 6	79581 3	5687 4	77305 8	35
26	3605 9	87200 7	4085 0	84491 7	4593 4	81944 9	5130 8	79542 3	5697 1	77268 9	34
27	3613 7	87154 1	4093 3	84447 9	4602 1	81903 7	5140 0	79503 4	5706 8	77232 0	33
28	3621 4	87107 5	4101 5	84404 3	4610 8	81862 6	5149 2	79464 6	5716 4	77195 2	32
29	3629 2	87061 0	4109 8	84360 6	4619 6	81821 5	5158 4	79425 7	5726 1	77158 4	31
30	3636 9	87014 6	4118 0	84317 0	4628 3	81780 4	5167 6	79386 9	5735 8	77121 6	30
31	3644 7	86968 2	4126 3	84273 5	4637 1	81739 4	5176 9	79348 1	5745 6	77084 9	29
32	3652 5	86921 9	4134 6	84230 0	4645 8	81698 4	5186 1	79309 4	5755 3	77048 2	28
33	3660 3	86875 6	4142 8	84186 5	4654 6	81657 5	5195 4	79270 7	5765 0	77011 5	27
34	3668 1	86829 4	4151 1	84143 1	4663 4	81616 6	5204 6	79232 1	5774 7	76974 8	26
35	3675 9	86783 2	4159 4	84099 8	4672 1	81575 7	5213 9	79193 4	5784 5	76938 2	25
36	3683 7	86737 0	4167 7	84056 5	4680 9	81534 9	5223 2	79154 8	5794 2	76901 6	24
37	3691 6	86690 9	4176 1	84013 2	4689 7	81494 1	5232 4	79116 3	5804 0	76865 1	23
38	3699 4	86644 9	4184 4	83969 9	4698 5	81453 4	5241 7	79077 8	5813 8	76828 5	22
39	3707 2	86598 9	4192 7	83926 8	4707 4	81412 6	5251 0	79039 3	5823 6	76792 1	21
40	3715 1	86553 0	4201 0	83883 6	4716 2	81372 0	5260 3	79000 8	5833 3	76755 6	20
41	3723 0	86507 1	4209 4	83840 5	4725 0	81331 4	5269 6	78962 4	5843 1	76719 2	19
42	3730 8	86461 3	4217 7	83797 5	4733 8	81290 8	5279 0	78924 0	5852 9	76682 8	18
43	3738 7	86415 5	4226 1	83754 4	4742 7	81250 2	5288 3	78885 7	5862 8	76646 4	17
44	3746 6	86369 7	4234 5	83711 5	4751 6	81209 7	5297 6	78847 4	5872 6	76610 1	16
45	3754 5	86324 0	4242 9	83668 5	4760 4	81169 2	5307 0	78809 1	5882 4	76573 8	15
46	3762 4	86278 4	4251 2	83625 7	4769 3	81128 8	5316 3	78770 9	5892 2	76537 5	14
47	3770 3	86232 8	4259 6	83582 8	4778 2	81088 4	5325 7	78732 6	5902 1	76501 3	13
48	3778 2	86187 2	4268 0	83540 0	4787 1	81048 1	5335 1	78694 5	5911 9	76465 1	12
49	3786 1	86141 8	4276 5	83497 3	4796 0	81007 7	5344 4	78656 3	5921 8	76428 9	11
50	3794 1	86096 3	4284 9	83454 6	4804 9	80967 5	5353 8	78618 2	5931 6	76392 7	10
51	3802 0	86050 9	4293 3	83411 9	4813 8	80927 2	5363 2	78580 2	5941 5	76356 6	9
52	3809 9	86005 6	4301 7	83369 3	4822 7	80887 0	5372 6	78542 1	5951 4	76320 5	8
53	3817 9	85960 2	4310 2	83326 7	4831 6	80846 8	5382 0	78504 1	5961 3	76284 5	7
54	3825 9	85915 0	4318 6	83284 1	4840 6	80806 7	5391 5	78466 2	5971 2	76248 5	6
55	3833 8	85869 8	4327 1	83241 6	4849 5	80766 6	5400 9	78428 2	5981 1	76212 5	5
56	3841 8	85824 6	4335 6	83199 2	4858 5	80726 6	5410 3	78390 3	5991 0	76176 5	4
57	3849 8	85779 5	4344 0	83156 8	4867 4	80686 6	5419 8	78352 5	6000 9	76140 6	3
58	3857 8	85734 5	4352 5	83114 4	4876 4	80646 6	5429 2	78314 6	6010 9	76104 7	2
59	3865 8	85689 4	4361 0	83072 1	4885 4	80606 7	5438 7	78276 8	6020 8	76068 8	1
60	3873 8	85644 5	4369 5	83029 8	4894 3	80566 8	5448 1	78239 1	6030 7	76033 0	0
	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	′
	74°	344°	73°	343°	72°	342°	71°	341°	70°	340°	

′	20°		21°		22°		23°		24°		′
	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	
0	6030 7	76033 0	6642 0	73936 7	7281 6	71940 1	7949 5	70034 5	8645 4	68212 1	60
1	6040 7	75997 2	6652 4	73902 6	7292 5	71907 6	7960 9	70003 4	8657 3	68182 4	59
2	6050 6	75961 4	6662 8	73868 6	7303 4	71875 2	7972 3	69972 4	8669 1	68152 7	58
3	6060 6	75925 6	6673 3	73834 6	7314 3	71842 7	7983 6	69941 4	8681 0	68123 1	57
4	6070 6	75889 9	6683 7	73800 6	7325 3	71810 3	7995 0	69910 5	8692 8	68093 4	56
5	6080 6	75854 2	6694 2	73766 6	7336 2	71778 0	8006 4	69879 5	8704 7	68063 8	55
6	6090 6	75818 6	6704 6	73732 7	7347 1	71745 6	8017 8	69848 6	8716 6	68034 2	54
7	6100 6	75783 0	6715 1	73698 8	7358 1	71713 3	8029 3	69817 7	8728 5	68004 6	53
8	6110 6	75747 4	6725 6	73664 9	7369 0	71681 0	8040 7	69786 8	8740 3	67975 1	52
9	6120 6	75711 8	6736 1	73631 1	7380 0	71648 7	8052 1	69756 0	8752 2	67945 5	51
10	6130 6	75676 3	6746 6	73597 3	7391 0	71616 4	8063 6	69725 2	8764 2	67916 0	50
11	6140 7	75640 8	6757 1	73563 5	7401 9	71584 2	8075 0	69694 3	8776 1	67886 5	49
12	6150 7	75605 3	6767 6	73529 7	7412 9	71552 0	8086 5	69663 6	8788 0	67857 0	48
13	6160 7	75569 8	6778 1	73496 0	7423 9	71519 8	8097 9	69632 8	8799 9	67827 6	47
14	6170 8	75534 4	6788 7	73462 3	7434 9	71487 6	8109 4	69602 1	8811 8	67798 1	46
15	6180 9	75499 0	6799 2	73428 6	7445 9	71455 5	8120 9	69571 3	8823 8	67768 7	45
16	6190 9	75463 7	6809 8	73394 9	7457 0	71423 4	8132 4	69540 7	8835 7	67739 3	44
17	6201 0	75428 3	6820 3	73361 3	7468 0	71391 3	8143 9	69510 0	8847 7	67710 0	43
18	6211 1	75393 1	6830 9	73327 7	7479 0	71359 2	8155 4	69479 3	8859 7	67680 6	42
19	6221 2	75357 8	6841 4	73294 1	7490 1	71327 2	8166 9	69448 7	8871 6	67651 3	41
20	6231 3	75322 5	6852 0	73260 5	7501 1	71295 2	8178 4	69418 1	8883 6	67622 0	40
21	6241 4	75287 3	6862 6	73227 0	7512 2	71263 2	8189 9	69387 5	8895 6	67592 7	39
22	6251 5	75252 2	6873 2	73193 5	7523 2	71231 2	8201 4	69357 0	8907 6	67563 4	38
23	6261 7	75217 0	6883 8	73160 1	7534 3	71199 3	8213 0	69326 4	8919 6	67534 2	37
24	6271 8	75181 9	6894 4	73126 6	7545 4	71167 4	8224 5	69295 9	8931 6	67505 0	36
25	6281 9	75146 8	6905 0	73093 2	7556 5	71135 5	8236 1	69265 4	8943 6	67475 7	35
26	6292 1	75111 7	6915 7	73059 8	7567 6	71103 6	8247 7	69235 0	8955 7	67446 6	34
27	6302 3	75076 7	6926 3	73026 4	7578 7	71071 8	8259 2	69204 5	8967 7	67417 4	33
28	6312 4	75041 7	6936 9	72993 1	7589 8	71040 0	8270 8	69174 1	8979 8	67388 3	32
29	6322 6	75006 7	6947 6	72959 8	7600 9	71008 2	8282 4	69143 7	8991 8	67359 1	31
30	6332 8	74971 8	6958 2	72926 5	7612 0	70976 4	8294 0	69113 3	9003 9	67330 0	30
31	6343 0	74936 9	6968 9	72893 3	7623 2	70944 7	8305 6	69083 0	9015 9	67300 9	29
32	6353 2	74902 0	6979 6	72860 0	7634 3	70913 0	8317 2	69052 6	9028 0	67271 9	28
33	6363 4	74867 1	6990 3	72826 8	7645 5	70881 3	8328 8	69022 3	9040 1	67242 8	27
34	6373 6	74832 3	7000 9	72793 6	7656 6	70849 6	8340 4	68992 0	9052 2	67213 8	26
35	6383 8	74797 5	7011 6	72760 5	7667 8	70818 0	8352 1	68961 8	9064 3	67184 8	25
36	6394 0	74762 7	7022 3	72727 4	7679 0	70786 3	8363 7	68931 5	9076 4	67155 8	24
37	6404 3	74728 0	7033 1	72694 3	7690 2	70754 7	8375 4	68901 3	9088 5	67126 9	23
38	6414 5	74693 3	7043 8	72661 2	7701 3	70723 2	8387 0	68871 1	9100 6	67097 9	22
39	6424 8	74658 6	7054 5	72628 2	7712 5	70691 6	8398 7	68840 9	9112 7	67069 0	21
40	6435 0	74623 9	7065 2	72595 1	7723 8	70660 1	8410 4	68810 7	9124 9	67040 1	20
41	6445 3	74589 3	7076 0	72562 1	7735 0	70628 6	8422 0	68780 6	9137 0	67011 2	19
42	6455 6	74554 7	7086 7	72529 2	7746 2	70597 1	8433 7	68750 5	9149 2	66982 4	18
43	6465 9	74520 1	7097 5	72496 2	7757 4	70565 6	8445 4	68720 4	9161 3	66953 5	17
44	6476 2	74485 6	7108 3	72463 3	7768 7	70534 2	8457 1	68690 3	9173 5	66924 7	16
45	6486 5	74451 0	7119 0	72430 4	7779 9	70502 8	8468 8	68660 3	9185 7	66895 9	15
46	6496 8	74416 6	7129 8	72397 5	7791 2	70471 4	8480 6	68630 2	9197 9	66867 1	14
47	6507 1	74382 1	7140 6	72364 7	7802 4	70440 0	8492 3	68600 2	9210 0	66838 4	13
48	6517 4	74347 7	7151 4	72331 9	7813 7	70408 7	8504 0	68570 3	9222 2	66809 7	12
49	6527 8	74313 3	7162 2	72299 1	7825 0	70377 4	8515 8	68540 3	9234 5	66780 9	11
50	6538 1	74278 9	7173 0	72266 3	7836 2	70346 1	8527 5	68510 3	9246 7	66752 2	10
51	6548 5	74244 6	7183 9	72233 6	7847 5	70314 8	8539 3	68480 4	9258 9	66723 6	9
52	6558 8	74210 2	7194 7	72200 9	7858 8	70283 6	8551 0	68450 5	9271 1	66694 9	8
53	6569 2	74175 9	7205 5	72168 2	7870 1	70252 4	8562 8	68420 7	9283 3	66666 3	7
54	6579 5	74141 7	7216 4	72135 5	7881 5	70221 2	8574 6	68390 8	9295 6	66637 6	6
55	6589 9	74107 4	7227 2	72102 9	7892 8	70190 0	8586 4	68361 0	9307 8	66609 0	5
56	6600 3	74073 2	7238 1	72070 3	7904 1	70158 8	8598 2	68331 1	9320 1	66580 5	4
57	6610 7	74039 1	7249 0	72037 7	7915 4	70127 7	8610 0	68301 4	9332 4	66551 9	3
58	6621 1	74004 9	7259 8	72005 2	7926 8	70096 6	8621 8	68271 6	9344 6	66523 3	2
59	6631 5	73970 8	7270 7	71972 6	7938 1	70065 5	8633 6	68241 8	9356 9	66494 8	1
60	6642 0	73936 7	7281 6	71940 1	7949 5	70034 5	8645 4	68212 1	9369 2	66466 3	0
	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	′
	69°	339°	68°	338°	67°	337°	66°	336°	65°	335°	

′	25°		26°		27°		28°		29°		
	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	
0	9369 2	66466 3	10120 6	64791 2	10899 3	63181 5	11705 2	61632 5	12538 0	60140 0	60
1	9381 5	66437 8	10133 3	64763 8	10912 6	63155 2	11718 9	61607 2	12552 1	60115 6	59
2	9393 8	66409 4	10146 1	64736 5	10925 8	63128 9	11732 6	61581 8	12566 2	60091 2	58
3	9406 1	66380 9	10158 9	64709 2	10939 0	63102 6	11746 2	61556 5	12580 4	60066 8	57
4	9418 5	66352 5	10171 7	64681 9	10952 2	63076 4	11759 9	61531 3	12594 5	60042 5	56
5	9430 8	66324 1	10184 4	64654 6	10965 5	63050 1	11773 6	61506 0	12608 6	60018 1	55
6	9443 1	66295 7	10197 2	64627 4	10978 7	63023 9	11787 3	61480 8	12622 8	59993 8	54
7	9455 5	66267 4	10210 0	64600 1	10992 0	62997 7	11801 0	61455 5	12636 9	59969 4	53
8	9467 8	66239 0	10222 8	64572 9	11005 2	62971 5	11814 7	61430 3	12651 1	59945 1	52
9	9480 2	66210 7	10235 7	64545 7	11018 5	62945 4	11828 4	61405 1	12665 2	59920 8	51
10	9492 5	66182 4	10248 5	64518 5	11031 8	62919 2	11842 2	61379 9	12679 4	59896 5	50
11	9504 9	66154 1	10261 3	64491 3	11045 1	62893 1	11855 9	61354 8	12693 6	59872 3	49
12	9517 3	66125 8	10274 2	64464 2	11058 4	62867 0	11869 6	61329 6	12707 8	59848 0	48
13	9529 7	66097 6	10287 0	64437 0	11071 7	62840 9	11883 4	61304 5	12722 0	59823 8	47
14	9542 1	66069 3	10299 9	64409 9	11085 0	62814 8	11897 2	61279 3	12736 2	59799 5	46
15	9554 5	66041 1	10312 7	64382 8	11098 3	62788 7	11910 9	61254 2	12750 4	59775 3	45
16	9566 9	66012 9	10325 6	64355 7	11111 6	62762 7	11924 7	61229 1	12764 6	59751 1	44
17	9579 3	65984 8	10338 5	64328 7	11124 9	62736 6	11938 5	61204 1	12778 8	59726 9	43
18	9591 7	65956 6	10351 4	64301 6	11138 3	62710 6	11952 3	61179 0	12793 1	59702 8	42
19	9604 2	65928 5	10364 2	64274 6	11151 6	62684 6	11966 1	61153 9	12807 3	59678 6	41
20	9616 6	65900 4	10377 1	64247 6	11165 0	62658 6	11979 9	61128 9	12821 6	59654 5	40
21	9629 1	65872 3	10390 1	64220 6	11178 3	62632 6	11993 7	61103 9	12835 8	59630 3	39
22	9641 5	65844 2	10403 0	64193 6	11191 7	62606 7	12007 5	61078 9	12850 1	59606 2	38
23	9654 0	65816 1	10415 9	64166 7	11205 1	62580 8	12021 3	61053 9	12864 3	59582 1	37
24	9666 5	65788 1	10428 8	64139 7	11218 5	62554 8	12035 1	61028 9	12878 6	59558 0	36
25	9678 9	65760 1	10441 8	64112 8	11231 8	62528 9	12049 0	61004 0	12892 9	59534 0	35
26	9691 4	65732 1	10454 7	64085 9	11245 2	62503 0	12062 8	60979 0	12907 2	59509 9	34
27	9703 9	65704 1	10467 7	64059 0	11258 7	62477 2	12076 7	60954 1	12921 5	59485 9	33
28	9716 4	65676 1	10480 6	64032 2	11272 1	62451 3	12090 5	60929 2	12935 8	59461 8	32
29	9728 9	65648 2	10493 6	64005 3	11285 5	62425 5	12104 4	60904 3	12950 1	59437 8	31
30	9741 5	65620 3	10506 6	63978 5	11298 9	62399 7	12118 3	60879 4	12964 4	59413 8	30
31	9754 0	65592 4	10519 5	63951 6	11312 3	62373 9	12132 2	60854 6	12978 8	59389 8	29
32	9766 5	65564 5	10532 5	63924 8	11325 8	62348 1	12146 1	60829 7	12993 1	59365 9	28
33	9779 1	65536 6	10545 5	63898 1	11339 2	62322 3	12160 0	60804 9	13007 4	59341 9	27
34	9791 6	65508 8	10558 5	63871 3	11352 7	62296 5	12173 9	60780 1	13021 8	59318 0	26
35	9804 2	65480 9	10571 6	63844 6	11366 2	62270 8	12187 8	60755 3	13036 1	59294 0	25
36	9816 7	65453 1	10584 6	63817 8	11379 6	62245 1	12201 7	60730 5	13050 5	59270 1	24
37	9829 3	65425 3	10597 6	63791 1	11393 1	62219 4	12215 6	60705 7	13064 9	59246 2	23
38	9841 9	65397 6	10610 6	63764 4	11406 6	62193 7	12229 6	60680 9	13079 3	59222 3	22
39	9854 5	65369 8	10623 7	63737 7	11420 1	62168 0	12243 5	60656 2	13093 6	59198 5	21
40	9867 1	65342 1	10636 7	63711 1	11433 6	62142 3	12257 5	60631 5	13108 0	59174 6	20
41	9879 7	65314 3	10649 8	63684 4	11447 1	62116 7	12271 4	60606 8	13122 4	59150 8	19
42	9892 3	65286 6	10662 9	63657 8	11460 6	62091 1	12285 4	60582 1	13136 8	59126 9	18
43	9904 9	65259 0	10675 9	63631 2	11474 2	62065 4	12299 4	60557 4	13151 3	59103 1	17
44	9917 5	65231 3	10689 0	63604 6	11487 7	62039 9	12313 3	60532 7	13165 7	59079 3	16
45	9930 2	65203 7	10702 1	63578 0	11501 2	62014 3	12327 3	60508 1	13180 1	59055 5	15
46	9942 8	65176 0	10715 2	63551 5	11514 8	61988 7	12341 3	60483 4	13194 6	59031 8	14
47	9955 5	65148 4	10728 3	63524 9	11528 3	61963 2	12355 3	60458 8	13209 0	59008 0	13
48	9968 1	65120 8	10741 4	63498 4	11541 9	61937 6	12369 3	60434 2	13223 4	58984 3	12
49	9980 8	65093 3	10754 5	63471 9	11555 5	61912 1	12383 3	60409 6	13237 9	58960 5	11
50	9993 5	65065 7	10767 7	63445 4	11569 0	61886 6	12397 4	60385 0	13252 4	58936 8	10
51	10006 1	65038 2	10780 8	63419 0	11582 6	61861 1	12411 4	60360 5	13266 9	58913 1	9
52	10018 8	65010 7	10793 9	63392 5	11596 2	61835 7	12425 4	60335 9	13281 3	58889 4	8
53	10031 5	64983 2	10807 1	63366 1	11609 8	61810 2	12439 5	60311 4	13295 8	58865 7	7
54	10044 2	64955 7	10820 2	63339 6	11623 4	61784 8	12453 5	60286 8	13310 3	58842 1	6
55	10056 9	64928 2	10833 4	63313 2	11637 0	61759 4	12467 6	60262 3	13324 8	58818 4	5
56	10069 6	64900 8	10846 6	63286 9	11650 7	61733 9	12481 7	60237 9	13339 3	58794 8	4
57	10082 4	64873 4	10859 8	63260 5	11664 3	61708 6	12495 8	60213 4	13353 9	58771 2	3
58	10095 1	64846 0	10872 9	63234 1	11677 9	61683 2	12509 8	60188 9	13368 4	58747 6	2
59	10107 8	64818 6	10886 1	63207 8	11691 6	61657 8	12523 9	60164 5	13382 9	58724 0	1
60	10120 6	64791 2	10899 3	63181 5	11705 2	61632 5	12538 0	60140 0	13397 5	58700 4	0
	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	′
	64°	334°	63°	333°	62°	332°	61°	331°	60°	330°	

′	30°		31°		32°		33°		34°		′
	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	
0	13397 5	58700 4	14283 3	57310 1	15195 2	55966 2	16132 9	54665 8	17096 2	53406 5	60
1	13412 0	58676 8	14298 3	57287 3	15210 6	55944 1	16148 8	54644 5	17112 5	53385 8	59
2	13426 6	58653 3	14313 2	57264 6	15226 0	55922 2	16164 6	54623 2	17128 8	53365 2	58
3	13441 1	58629 7	14328 2	57241 8	15241 5	55900 2	16180 5	54601 9	17145 1	53344 5	57
4	13455 7	58606 2	14343 3	57219 1	15256 9	55878 2	16196 4	54580 6	17161 4	53323 9	56
5	13470 3	58582 7	14358 3	57196 4	15272 3	55856 2	16212 2	54559 3	17177 7	53303 3	55
6	13484 9	58559 2	14373 3	57173 7	15287 8	55834 2	16228 1	54538 1	17194 0	53282 7	54
7	13499 4	58535 7	14388 3	57151 0	15303 3	55812 3	16244 0	54516 8	17210 3	53262 1	53
8	13514 0	58512 2	14403 4	57128 3	15318 7	55790 4	16259 9	54495 6	17226 6	53241 5	52
9	13528 7	58488 8	14418 4	57105 6	15334 2	55768 4	16275 8	54474 4	17242 9	53221 0	51
10	13543 3	58465 3	14433 4	57083 0	15349 7	55746 5	16291 7	54453 1	17259 3	53200 4	50
11	13557 9	58441 9	14448 5	57060 3	15365 2	55724 6	16307 6	54431 9	17275 6	53179 8	49
12	13572 5	58418 5	14463 6	57037 7	15380 7	55702 7	16323 6	54410 7	17291 9	53159 3	48
13	13587 2	58395 1	14478 6	57015 1	15396 2	55680 8	16339 5	54389 6	17308 3	53138 8	47
14	13601 8	58371 7	14493 7	56992 5	15411 7	55659 0	16355 4	54368 4	17324 7	53118 3	46
15	13616 4	58348 3	14508 8	56969 9	15427 2	55637 1	16371 4	54347 2	17341 0	53097 8	45
16	13631 1	58324 9	14523 9	56947 3	15442 7	55615 3	16387 3	54326 1	17357 4	53077 3	44
17	13645 8	58301 6	14539 0	56924 8	15458 3	55593 4	16403 3	54304 9	17373 8	53056 8	43
18	13660 4	58278 3	14554 1	56902 2	15473 8	55571 6	16419 3	54283 8	17390 2	53036 3	42
19	13675 1	58254 9	14569 2	56879 7	15489 4	55549 8	16435 2	54262 7	17406 6	53015 8	41
20	13689 8	58231 6	14584 4	56857 1	15504 9	55528 0	16451 2	54241 6	17423 0	52995 4	40
21	13704 5	58208 3	14599 5	56834 6	15520 5	55506 2	16467 2	54220 5	17439 4	52974 9	39
22	13719 2	58185 0	14614 6	56812 1	15536 0	55484 5	16483 2	54199 4	17455 8	52954 5	38
23	13733 9	58161 8	14629 8	56789 6	15551 6	55462 7	16499 2	54178 3	17472 2	52934 1	37
24	13748 6	58138 5	14644 9	56767 1	15567 2	55441 0	16515 2	54157 3	17488 7	52913 7	36
25	13763 4	58115 3	14660 1	56744 7	15582 8	55419 2	16531 2	54136 2	17505 1	52893 3	35
26	13778 1	58092 1	14675 2	56722 2	15598 4	55397 5	16547 3	54115 2	17521 5	52872 9	34
27	13792 8	58068 8	14690 4	56699 8	15614 0	55375 8	16563 3	54094 2	17538 0	52852 5	33
28	13807 6	58045 6	14705 6	56677 4	15629 6	55354 1	16579 3	54073 2	17554 4	52832 1	32
29	13822 3	58022 4	14720 8	56654 9	15645 2	55332 4	16595 4	54052 2	17570 9	52811 8	31
30	13837 1	57999 3	14736 0	56632 5	15660 9	55310 7	16611 4	54031 2	17587 4	52791 4	30
31	13851 8	57976 1	14751 2	56610 2	15676 5	55289 1	16627 5	54010 2	17603 9	52771 1	29
32	13866 6	57953 0	14766 4	56587 8	15692 1	55267 4	16643 5	53989 2	17620 3	52750 8	28
33	13881 4	57929 8	14781 6	56565 4	15707 8	55245 8	16659 6	53968 3	17636 8	52730 5	27
34	13896 2	57906 7	14796 8	56543 1	15723 4	55224 1	16675 7	53947 3	17653 3	52710 2	26
35	13911 0	57883 6	14812 1	56520 7	15739 1	55202 5	16691 8	53926 4	17669 8	52689 9	25
36	13925 8	57860 5	14827 3	56498 4	15754 8	55180 9	16707 9	53905 4	17686 4	52669 6	24
37	13940 6	57837 4	14842 5	56476 1	15770 4	55159 3	16724 0	53884 5	17702 9	52649 3	23
38	13955 4	57814 3	14857 8	56453 8	15786 1	55137 7	16740 1	53863 6	17719 4	52629 0	22
39	13970 2	57791 3	14873 1	56431 5	15801 8	55116 2	16756 2	53842 7	17735 9	52608 8	21
40	13985 1	57768 2	14888 3	56409 2	15817 5	55094 6	16772 3	53821 8	17752 5	52588 5	20
41	13999 9	57745 2	14903 6	56386 9	15833 2	55073 1	16788 5	53801 0	17769 0	52568 3	19
42	14014 8	57722 2	14918 9	56364 7	15848 9	55051 5	16804 6	53780 1	17785 6	52548 1	18
43	14029 6	57699 2	14934 2	56342 4	15864 6	55030 0	16820 7	53759 3	17802 2	52527 9	17
44	14044 5	57676 2	14949 5	56320 2	15880 4	55008 5	16836 9	53738 4	17818 7	52507 7	16
45	14059 4	57653 2	14964 8	56298 0	15896 1	54987 0	16853 0	53717 6	17835 3	52487 5	15
46	14074 2	57630 3	14980 1	56275 8	15911 8	54965 5	16869 2	53696 8	17851 9	52467 3	14
47	14089 1	57607 3	14995 4	56253 6	15927 6	54944 0	16885 4	53676 0	17868 5	52447 1	13
48	14104 0	57584 4	15010 7	56231 4	15943 3	54922 5	16901 6	53655 2	17885 1	52427 0	12
49	14118 9	57561 4	15026 1	56209 2	15959 1	54901 1	16917 7	53634 4	17901 7	52406 8	11
50	14133 8	57538 5	15041 4	56187 1	15974 9	54879 6	16933 9	53613 6	17918 3	52386 7	10
51	14148 7	57515 6	15056 7	56164 9	15990 6	54858 2	16950 1	53592 8	17934 9	52366 5	9
52	14163 6	57492 7	15072 1	56142 8	16006 4	54836 8	16966 3	53572 1	17951 5	52346 4	8
53	14178 6	57469 9	15087 5	56120 7	16022 2	54815 4	16982 6	53551 4	17968 2	52326 3	7
54	14193 5	57447 0	15102 8	56098 6	16038 0	54794 0	16998 8	53530 6	17984 8	52306 2	6
55	14208 4	57424 2	15118 2	56076 5	16053 8	54772 6	17015 0	53509 9	18001 5	52286 1	5
56	14223 4	57401 3	15133 6	56054 4	16069 6	54751 2	17031 2	53489 2	18018 1	52266 0	4
57	14238 4	57378 5	15149 0	56032 3	16085 4	54729 8	17047 5	53468 5	18034 8	52246 0	3
58	14253 3	57355 7	15164 4	56010 3	16101 3	54708 5	17063 7	53447 8	18051 4	52225 9	2
59	14268 3	57332 9	15179 8	55988 2	16117 1	54687 1	17080 0	53427 1	18068 1	52205 9	1
60	14283 3	57310 1	15195 2	55966 2	16132 9	54665 8	17096 2	53406 5	18084 8	52185 8	0
	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	′
	59°	329°	58°	328°	57°	327°	56°	326°	55°	325°	

′	35°		36°		37°		38°		39°		′
	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	
0	18084 8	52185 8	19098 3	51001 8	20136 4	49852 4	21198 9	48735 8	22285 4	47650 5	60
1	18101 5	52165 8	19115 4	50982 3	20154 0	49833 5	21216 8	48717 5	22303 7	47632 6	59
2	18118 2	52145 8	19132 5	50962 9	20171 5	49814 6	21234 8	48699 1	22322 0	47614 8	58
3	18134 9	52125 8	19149 6	50943 5	20189 0	49795 8	21252 7	48680 8	22340 4	47597 0	57
4	18151 6	52105 8	19166 7	50924 1	20206 5	49776 9	21270 6	48662 5	22358 7	47579 2	56
5	18168 3	52085 8	19183 9	50904 7	20224 1	49758 1	21288 6	48644 2	22377 0	47561 4	55
6	18185 0	52065 8	19201 0	50885 3	20241 6	49739 3	21306 5	48625 9	22395 4	47543 6	54
7	18201 8	52045 8	19218 1	50865 9	20259 2	49720 4	21324 4	48607 6	22413 7	47525 8	53
8	18218 5	52025 9	19235 3	50846 5	20276 7	49701 6	21342 4	48589 3	22432 1	47508 0	52
9	18235 2	52005 9	19252 5	50827 2	20294 3	49682 8	21360 4	48571 1	22450 4	47490 3	51
10	18252 0	51986 0	19269 6	50807 8	20311 8	49664 0	21378 3	48552 8	22468 8	47472 5	50
11	18268 7	51966 1	19286 8	50788 5	20329 4	49645 2	21396 3	48534 5	22487 2	47454 8	49
12	18285 5	51946 1	19304 0	50769 2	20347 0	49626 5	21414 3	48516 3	22505 6	47437 0	48
13	18302 3	51926 2	19321 1	50749 8	20364 6	49607 7	21432 3	48498 1	22523 9	47419 3	47
14	18319 1	51906 3	19338 3	50730 5	20382 2	49589 0	21450 3	48479 8	22542 3	47401 6	46
15	18335 8	51886 5	19355 5	50711 2	20399 8	49570 2	21468 3	48461 6	22560 7	47383 8	45
16	18352 6	51866 6	19372 7	50691 9	20417 4	49551 5	21486 3	48443 4	22579 1	47366 1	44
17	18369 4	51846 7	19389 9	50672 7	20435 0	49532 7	21504 3	48425 2	22597 6	47348 4	43
18	18386 2	51826 9	19407 2	50653 4	20452 7	49514 0	21522 4	48407 0	22616 0	47330 7	42
19	18403 0	51807 0	19424 4	50634 1	20470 3	49495 3	21540 4	48388 8	22634 4	47313 0	41
20	18419 9	51787 2	19441 6	50614 9	20487 9	49476 6	21558 4	48370 6	22652 8	47295 4	40
21	18436 7	51767 3	19458 9	50595 6	20505 6	49457 9	21576 5	48352 5	22671 3	47277 7	39
22	18453 5	51747 5	19476 1	50576 4	20523 2	49439 2	21594 5	48334 3	22689 7	47260 0	38
23	18470 4	51727 7	19493 4	50557 2	20540 9	49420 6	21612 6	48316 2	22708 2	47242 4	37
24	18487 2	51707 9	19510 6	50537 9	20558 5	49401 9	21630 6	48298 0	22726 6	47224 7	36
25	18504 1	51688 1	19527 9	50518 7	20576 2	49383 2	21648 7	48279 9	22745 1	47207 1	35
26	18520 9	51668 4	19545 2	50499 5	20593 9	49364 6	21666 8	48261 8	22763 6	47189 5	34
27	18537 8	51648 6	19562 4	50480 4	20611 6	49345 9	21684 9	48243 6	22782 1	47171 8	33
28	18554 7	51628 8	19579 7	50461 2	20629 3	49327 3	21703 0	48225 5	22800 5	47154 2	32
29	18571 6	51609 1	19597 0	50442 0	20647 0	49308 7	21721 1	48207 4	22819 0	47136 6	31
30	18588 4	51589 3	19614 3	50422 8	20664 7	49290 1	21739 2	48189 3	22837 5	47119 0	30
31	18605 3	51569 6	19631 6	50403 7	20682 4	49271 5	21757 3	48171 3	22856 0	47101 4	29
32	18622 2	51549 9	19648 9	50384 6	20700 1	49252 9	21775 4	48153 2	22874 6	47083 9	28
33	18639 2	51530 2	19666 2	50365 4	20717 8	49234 3	21793 5	48135 1	22893 1	47066 3	27
34	18656 1	51510 5	19683 6	50346 3	20735 6	49215 7	21811 7	48117 1	22911 6	47048 7	26
35	18673 0	51490 8	19700 9	50327 2	20753 3	49197 2	21829 8	48099 0	22930 1	47031 2	25
36	18689 9	51471 1	19718 2	50308 1	20771 0	49178 6	21848 0	48081 0	22948 7	47013 6	24
37	18706 9	51451 5	19735 6	50289 0	20788 8	49160 0	21866 1	48062 9	22967 2	46996 1	23
38	18723 8	51431 8	19752 9	50269 9	20806 5	49141 5	21884 3	48044 9	22985 8	46978 5	22
39	18740 8	51412 1	19770 3	50250 8	20824 3	49123 0	21902 4	48026 9	23004 3	46961 0	21
40	18757 7	51392 5	19787 7	50231 8	20842 1	49104 4	21920 6	48008 9	23022 9	46943 5	20
41	18774 7	51372 9	19805 0	50212 7	20859 9	49085 9	21938 8	47990 9	23041 5	46926 0	19
42	18791 6	51353 3	19822 4	50193 6	20877 6	49067 4	21957 0	47972 9	23060 0	46908 5	18
43	18808 6	51333 6	19839 8	50174 6	20895 4	49048 9	21975 1	47954 9	23078 6	46891 0	17
44	18825 6	51314 0	19857 2	50155 6	20913 2	49030 4	21993 3	47936 9	23097 2	46873 5	16
45	18842 6	51294 5	19874 6	50136 6	20931 0	49012 0	22011 6	47919 0	23115 8	46856 0	15
46	18859 6	51274 9	19892 0	50117 5	20948 8	48993 5	22029 8	47901 0	23134 4	46838 6	14
47	18876 6	51255 3	19909 4	50098 5	20966 7	48975 0	22048 0	47883 1	23153 0	46821 1	13
48	18893 6	51235 7	19926 9	50079 6	20984 5	48956 6	22066 2	47865 1	23171 6	46803 7	12
49	18910 6	51216 2	19944 3	50060 6	21002 3	48938 1	22084 4	47847 2	23190 3	46786 2	11
50	18927 7	51196 6	19961 7	50041 6	21020 2	48919 7	22102 7	47829 3	23208 9	46768 8	10
51	18944 7	51177 1	19979 2	50022 6	21038 0	48901 3	22120 9	47811 3	23227 5	46751 3	9
52	18961 7	51157 6	19996 6	50003 7	21055 9	48882 8	22139 2	47793 4	23246 2	46733 9	8
53	18978 8	51138 1	20014 1	49984 7	21073 7	48864 4	22157 4	47775 5	23264 8	46716 5	7
54	18995 8	51118 6	20031 5	49965 8	21091 6	48846 0	22175 7	47757 6	23283 5	46699 1	6
55	19012 9	51099 1	20049 0	49946 9	21109 5	48827 6	22194 0	47739 8	23302 1	46681 7	5
56	19030 0	51079 6	20066 5	49927 9	21127 3	48809 3	22212 2	47721 9	23320 8	46664 3	4
57	19047 0	51060 1	20084 0	49909 0	21145 2	48790 9	22230 5	47704 0	23339 5	46646 9	3
58	19064 1	51040 7	20101 5	49890 1	21163 1	48772 5	22248 8	47686 2	23358 2	46629 6	2
59	19081 2	51021 2	20118 9	49871 2	21181 0	48754 2	22267 1	47668 3	23376 9	46612 2	1
60	19098 3	51001 8	20136 4	49852 4	21198 9	48735 8	22285 4	47650 5	23395 6	46594 8	0
	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	′
	54°	324°	53°	323°	52°	322°	51°	321°	50°	320°	

′	40°		41°		42°		43°		44°		′
	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	
0	23395 6	46594 8	24529 0	45567 5	25685 5	44567 1	26864 6	43592 5	28066 0	42642 5	60
1	23414 3	46577 5	24548 1	45550 6	25705 0	44550 6	26884 5	43576 4	28086 2	42626 8	59
2	23433 0	46560 1	24567 2	45533 7	25724 5	44534 2	26904 3	43560 4	28106 4	42611 2	58
3	23451 7	46542 8	24586 3	45516 8	25743 9	44517 8	26924 2	43544 4	28126 7	42595 6	57
4	23470 4	46525 5	24605 4	45500 0	25763 4	44501 3	26944 0	43528 4	28146 9	42580 0	56
5	23489 1	46508 2	24624 5	45483 1	25782 9	44484 9	26963 9	43512 4	28167 1	42564 4	55
6	23507 9	46490 8	24643 7	45466 2	25802 4	44468 5	26983 8	43496 4	28187 4	42548 8	54
7	23526 6	46473 5	24662 8	45449 4	25821 9	44452 1	27003 7	43480 4	28207 6	42533 2	53
8	23545 3	46456 2	24681 9	45432 6	25841 4	44435 7	27023 5	43464 4	28227 9	42517 6	52
9	23564 1	46439 0	24701 1	45415 7	25860 9	44419 3	27043 4	43448 4	28248 1	42502 0	51
10	23582 9	46421 7	24720 2	45398 9	25880 5	44402 9	27063 3	43432 4	28268 4	42486 4	50
11	23601 6	46404 4	24739 4	45382 1	25900 0	44386 5	27083 2	43416 5	28288 7	42470 9	49
12	23620 4	46387 1	24758 5	45365 3	25919 5	44370 1	27103 1	43400 5	28308 9	42455 3	48
13	23639 2	46369 9	24777 7	45348 5	25939 1	44353 8	27123 0	43384 6	28329 2	42439 8	47
14	23658 0	46352 6	24796 8	45331 7	25958 6	44337 4	27143 0	43368 6	28349 5	42424 2	46
15	23676 8	46335 4	24816 0	45314 9	25978 2	44321 1	27162 9	43352 7	28369 8	42408 7	45
16	23695 6	46318 2	24835 2	45298 1	25997 7	44304 7	27182 8	43336 8	28390 1	42393 1	44
17	23714 4	46300 9	24854 4	45281 3	26017 3	44288 4	27202 8	43320 8	28410 4	42377 6	43
18	23733 2	46283 7	24873 6	45264 6	26036 9	44272 0	27222 7	43304 9	28430 7	42362 1	42
19	23752 0	46266 5	24892 8	45247 8	26056 5	44255 7	27242 7	43289 0	28451 0	42346 6	41
20	23770 8	46249 3	24912 0	45231 1	26076 1	44239 4	27262 6	43273 1	28471 4	42331 1	40
21	23789 6	46232 1	24931 2	45214 3	26095 7	44223 1	27282 6	43257 2	28491 7	42315 6	39
22	23808 5	46214 9	24950 4	45197 6	26115 2	44206 8	27302 6	43241 3	28512 0	42300 1	38
23	23827 3	46197 7	24969 7	45180 9	26134 9	44190 5	27322 5	43225 4	28532 4	42284 6	37
24	23846 2	46180 6	24988 9	45164 1	26154 5	44174 2	27342 5	43209 6	28552 7	42269 1	36
25	23865 0	46163 4	25008 1	45147 4	26174 1	44157 9	27362 5	43193 7	28573 1	42253 6	35
26	23883 9	46146 2	25027 4	45130 7	26193 7	44141 7	27382 5	43177 8	28593 4	42238 2	34
27	23902 8	46129 1	25046 6	45114 0	26213 3	44125 4	27402 5	43162 0	28613 8	42222 7	33
28	23921 6	46112 0	25065 9	45097 3	26233 0	44109 1	27422 5	43146 1	28634 2	42207 3	32
29	23940 5	46094 8	25085 2	45080 7	26252 6	44092 9	27442 5	43130 3	28654 6	42191 8	31
30	23959 4	46077 7	25104 4	45064 0	26272 3	44076 6	27462 6	43114 4	28675 0	42176 4	30
31	23978 3	46060 6	25123 7	45047 3	26291 9	44060 4	27482 6	43098 6	28695 3	42160 9	29
32	23997 2	46043 5	25143 0	45030 7	26311 6	44044 2	27502 6	43082 8	28715 7	42145 5	28
33	24016 1	46026 4	25162 3	45014 0	26331 3	44027 9	27522 7	43067 0	28736 1	42130 1	27
34	24035 0	46009 3	25181 6	44997 4	26350 9	44011 7	27542 7	43051 2	28756 6	42114 7	26
35	24053 9	45992 2	25200 9	44980 7	26370 6	43995 5	27562 8	43035 4	28777 0	42099 2	25
36	24072 9	45975 1	25220 2	44964 1	26390 3	43979 3	27582 8	43019 6	28797 4	42083 8	24
37	24091 8	45958 0	25239 5	44947 5	26410 0	43963 1	27602 9	43003 8	28817 8	42068 4	23
38	24110 7	45941 0	25258 8	44930 8	26429 7	43946 9	27622 9	42988 0	28838 3	42053 0	22
39	24129 7	45923 9	25278 2	44914 2	26449 4	43930 7	27643 0	42972 2	28858 7	42037 7	21
40	24148 6	45906 9	25297 5	44897 6	26469 1	43914 5	27663 1	42956 5	28879 1	42022 3	20
41	24167 6	45889 8	25316 8	44881 0	26488 8	43898 4	27683 2	42940 7	28899 6	42006 9	19
42	24186 6	45872 8	25336 2	44864 4	26508 5	43882 2	27703 3	42924 9	28920 1	41991 5	18
43	24205 5	45855 8	25355 5	44847 9	26528 3	43866 1	27723 4	42909 2	28940 5	41976 2	17
44	24224 5	45838 7	25374 9	44831 3	26548 0	43849 9	27743 5	42893 4	28961 0	41960 8	16
45	24243 5	45821 7	25394 3	44814 7	26567 7	43833 8	27763 6	42877 7	28981 5	41945 5	15
46	24262 5	45804 7	25413 6	44798 2	26587 5	43817 6	27783 7	42862 0	29001 9	41930 1	14
47	24281 5	45787 7	25433 0	44781 6	26607 3	43801 5	27803 8	42846 3	29022 4	41914 8	13
48	24300 5	45770 7	25452 4	44765 1	26627 0	43785 4	27824 0	42830 5	29042 9	41899 5	12
49	24319 5	45753 8	25471 8	44748 5	26646 8	43769 3	27844 1	42814 8	29063 4	41884 2	11
50	24338 5	45736 8	25491 2	44732 0	26666 6	43753 2	27864 3	42799 1	29083 9	41868 8	10
51	24357 5	45719 8	25510 6	44715 5	26686 3	43737 1	27884 4	42783 4	29104 4	41853 5	9
52	24376 6	45702 9	25530 0	44699 0	26706 1	43721 0	27904 6	42767 7	29125 0	41838 2	8
53	24395 6	45685 9	25549 4	44682 4	26725 9	43704 9	27924 7	42752 1	29145 5	41822 9	7
54	24414 6	45669 0	25568 8	44665 9	26745 7	43688 8	27944 9	42736 4	29166 0	41807 6	6
55	24433 7	45652 0	25588 3	44649 4	26765 5	43672 7	27965 1	42720 7	29186 5	41792 4	5
56	24452 8	45635 1	25607 7	44633 0	26785 3	43656 7	27985 2	42705 0	29207 1	41777 1	4
57	24471 8	45618 2	25627 2	44616 5	26805 1	43640 6	28005 4	42689 4	29227 6	41761 8	3
58	24490 9	45601 3	25646 6	44600 0	26825 0	43624 5	28025 6	42673 7	29248 2	41746 5	2
59	24510 0	45584 4	25666 1	44583 5	26844 8	43608 5	28045 8	42658 1	29268 8	41731 3	1
60	24529 0	45567 5	25685 5	44567 1	26864 6	43592 5	28066 0	42642 5	29289 3	41716 0	0
	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	′
	49°	319°	48°	318°	47°	317°	46°	316°	45°	315°	

′	45°		46°		47°		48°		49°		
	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	
0	29289 3	41716 0	30534 2	40812 2	31800 2	39930 0	33086 9	39068 7	34394 1	38227 3	60
1	29309 9	41700 8	30555 1	40797 3	31821 4	39915 5	33108 6	39054 5	34416 0	38213 4	59
2	29330 5	41685 5	30576 0	40782 4	31842 7	39901 0	33130 2	39040 3	34438 0	38199 6	58
3	29351 1	41670 3	30597 0	40767 6	31864 0	39886 5	33151 8	39026 1	34460 0	38185 7	57
4	29371 6	41655 1	30617 9	40752 7	31885 3	39872 0	33173 5	39012 0	34482 0	38171 9	56
5	29392 2	41639 9	30638 9	40737 9	31906 6	39857 5	33195 1	38997 8	34503 9	38158 1	55
6	29412 8	41624 6	30659 8	40723 0	31927 9	39843 0	33216 7	38983 6	34525 9	38144 2	54
7	29433 4	41609 4	30680 8	40708 2	31949 2	39828 5	33238 4	38969 5	34547 9	38130 4	53
8	29454 1	41594 2	30701 7	40693 3	31970 5	39814 0	33260 1	38955 3	34569 9	38116 6	52
9	29474 7	41579 0	30722 7	40678 5	31991 9	39799 5	33281 7	38941 2	34591 9	38102 8	51
10	29495 3	41563 9	30743 7	40663 7	32013 2	39785 0	33303 4	38927 1	34613 9	38089 0	50
11	29515 9	41548 7	30764 7	40648 9	32034 5	39770 5	33325 1	38912 9	34635 9	38075 2	49
12	29536 6	41533 5	30785 7	40634 1	32055 9	39756 1	33346 8	38898 8	34657 9	38061 4	48
13	29557 2	41518 3	30806 7	40619 3	32077 2	39741 7	33368 4	38884 7	34680 0	38047 6	47
14	29577 9	41503 2	30827 7	40604 5	32098 6	39727 2	33390 1	38870 6	34702 0	38033 8	46
15	29598 5	41488 0	30848 7	40589 7	32119 9	39712 8	33411 8	38856 5	34724 0	38020 0	45
16	29619 2	41472 8	30869 7	40574 9	32141 3	39698 3	33433 5	38842 4	34746 1	38006 2	44
17	29639 9	41457 7	30890 7	40560 1	32162 7	39683 9	33455 2	38828 3	34768 1	37992 4	43
18	29660 5	41442 6	30911 8	40545 3	32184 0	39669 5	33477 0	38814 2	34790 2	37978 7	42
19	29681 2	41427 4	30932 8	40530 5	32205 4	39655 1	33498 7	38800 1	34812 2	37964 9	41
20	29701 9	41412 3	30953 8	40515 8	32226 8	39640 6	33520 4	38786 0	34834 3	37951 2	40
21	29722 6	41397 2	30974 9	40501 0	32248 2	39626 2	33542 1	38772 0	34856 3	37937 4	39
22	29743 3	41382 1	30995 9	40486 3	32269 6	39611 8	33563 9	38757 9	34878 4	37923 7	38
23	29764 0	41366 9	31017 0	40471 5	32291 0	39597 4	33585 6	38743 8	34900 5	37909 9	37
24	29784 7	41351 8	31038 0	40456 8	32312 4	39583 0	33607 4	38729 8	34922 6	37896 2	36
25	29805 4	41336 7	31059 1	40442 0	32333 8	39568 7	33629 1	38715 7	34944 7	37882 5	35
26	29826 1	41321 7	31080 2	40427 3	32355 2	39554 3	33650 9	38701 7	34966 8	37868 7	34
27	29846 9	41306 6	31101 3	40412 6	32376 7	39539 9	33672 7	38687 6	34988 9	37855 0	33
28	29867 6	41291 5	31122 4	40397 9	32398 1	39525 5	33694 4	38673 6	35011 0	37841 3	32
29	29888 3	41276 4	31143 4	40383 2	32419 5	39511 2	33716 2	38659 6	35033 1	37827 6	31
30	29909 1	41261 4	31164 5	40368 5	32441 0	39496 8	33738 0	38645 5	35055 2	37813 9	30
31	29929 8	41246 3	31185 6	40353 8	32462 4	39482 4	33759 8	38631 5	35077 3	37800 2	29
32	29950 6	41231 2	31206 8	40339 1	32483 9	39468 1	33781 6	38617 5	35099 4	37786 5	28
33	29971 3	41216 2	31227 9	40324 4	32505 3	39453 8	33803 4	38603 5	35121 6	37772 8	27
34	29992 1	41201 1	31249 0	40309 7	32526 8	39439 4	33825 2	38589 5	35143 7	37759 1	26
35	30012 9	41186 1	31270 1	40295 0	32548 3	39425 1	33847 0	38575 5	35165 9	37745 4	25
36	30033 7	41171 1	31291 2	40280 4	32569 8	39410 8	33868 8	38561 5	35188 0	37731 8	24
37	30054 5	41156 1	31312 4	40265 7	32591 2	39396 5	33890 6	38547 5	35210 2	37718 1	23
38	30075 2	41141 0	31333 5	40251 0	32612 7	39382 1	33912 5	38533 5	35232 3	37704 4	22
39	30096 0	41126 0	31354 7	40236 4	32634 2	39367 8	33934 3	38519 6	35254 5	37690 8	21
40	30116 8	41111 0	31375 8	40221 7	32655 7	39353 5	33956 1	38505 6	35276 7	37677 1	20
41	30137 7	41096 0	31397 0	40207 1	32677 2	39339 2	33978 0	38491 6	35298 8	37663 5	19
42	30158 5	41081 0	31418 2	40192 5	32698 7	39324 9	33999 8	38477 7	35321 0	37649 8	18
43	30179 3	41066 0	31439 3	40177 8	32720 3	39310 7	34021 7	38463 7	35343 2	37636 2	17
44	30200 1	41051 1	31460 5	40163 2	32741 8	39296 4	34043 5	38449 8	35365 4	37622 6	16
45	30221 0	41036 1	31481 7	40148 6	32763 3	39282 1	34065 4	38435 8	35387 6	37608 9	15
46	30241 8	41021 1	31502 9	40134 0	32784 9	39267 8	34087 3	38421 9	35409 8	37595 3	14
47	30262 6	41006 2	31524 1	40119 4	32806 4	39253 6	34109 2	38407 9	35432 0	37581 7	13
48	30283 5	40991 2	31545 3	40104 8	32827 9	39239 3	34131 0	38394 0	35454 2	37568 1	12
49	30304 3	40976 3	31566 5	40090 2	32849 5	39225 1	34152 9	38380 1	35476 4	37554 5	11
50	30325 2	40961 3	31587 7	40075 6	32871 0	39210 8	34174 8	38366 2	35498 7	37540 9	10
51	30346 1	40946 4	31608 9	40061 0	32892 6	39196 6	34196 7	38352 3	35520 9	37527 3	9
52	30367 0	40931 4	31630 2	40046 4	32914 2	39182 3	34218 6	38338 4	35543 1	37513 7	8
53	30387 8	40916 5	31651 4	40031 9	32935 8	39168 1	34240 6	38324 5	35565 4	37500 1	7
54	30408 7	40901 6	31672 6	40017 3	32957 3	39153 9	34262 5	38310 6	35587 6	37486 5	6
55	30429 6	40886 7	31693 9	40002 7	32978 9	39139 7	34284 4	38296 7	35609 9	37473 0	5
56	30450 5	40871 8	31715 1	39988 2	33000 5	39125 5	34306 3	38282 8	35632 1	37459 4	4
57	30471 4	40856 9	31736 4	39973 6	33022 1	39111 3	34328 3	38268 9	35654 4	37445 8	3
58	30492 3	40842 0	31757 6	39959 1	33043 7	39097 1	34350 2	38255 0	35676 7	37432 3	2
59	30513 2	40827 1	31778 9	39944 6	33065 3	39082 9	34372 1	38241 2	35699 0	37418 7	1
60	30534 2	40812 2	31800 2	39930 0	33086 9	39068 7	34394 1	38227 3	35721 2	37405 2	0
	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	′
	44°	314°	43°	313°	42°	312°	41°	311°	40°	310°	

′	50°		51°		52°		53°		54°		′
	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	
0	35721 2	37405 2	37068 0	36601 6	38433 9	35815 8	39818 5	35047 3	41221 5	34295 3	60
1	35743 5	37391 6	37090 6	36588 3	38456 8	35802 9	39841 7	35034 6	41245 0	34282 9	59
2	35765 8	37378 1	37113 2	36575 1	38479 7	35789 9	39865 0	35021 9	41268 5	34270 5	58
3	35788 1	37364 6	37135 8	36561 9	38502 6	35777 0	39888 2	35009 3	41292 1	34258 2	57
4	35810 4	37351 0	37158 4	36548 6	38525 6	35764 0	39911 5	34996 6	41315 6	34245 8	56
5	35832 7	37337 5	37181 1	36535 4	38548 5	35751 1	39934 7	34984 0	41339 2	34233 4	55
6	35855 0	37324 0	37203 7	36522 2	38571 5	35738 2	39958 0	34971 3	41362 8	34221 0	54
7	35877 4	37310 5	37226 3	36509 0	38594 4	35725 3	39981 2	34958 7	41386 3	34208 7	53
8	35899 7	37297 0	37249 0	36495 8	38617 4	35712 3	40004 5	34946 1	41409 9	34196 3	52
9	35922 0	37283 5	37271 6	36482 6	38640 4	35699 4	40027 8	34933 4	41433 5	34183 9	51
10	35944 3	37270 0	37294 3	36469 4	38663 3	35686 5	40051 1	34920 8	41457 1	34171 6	50
11	35966 7	37256 5	37317 0	36456 2	38686 3	35673 6	40074 4	34908 2	41480 6	34159 2	49
12	35989 0	37243 0	37339 6	36443 0	38709 3	35660 7	40097 6	34895 6	41504 2	34146 9	48
13	36011 4	37229 5	37362 3	36429 8	38732 3	35647 8	40120 9	34882 9	41527 8	34134 5	47
14	36033 7	37216 0	37385 0	36416 6	38755 3	35635 0	40144 2	34870 3	41551 4	34122 2	46
15	36056 1	37202 6	37407 7	36403 5	38778 3	35622 1	40167 5	34857 7	41575 0	34109 9	45
16	36078 5	37189 1	37430 3	36390 3	38801 3	35609 2	40190 8	34845 1	41598 6	34097 5	44
17	36100 8	37175 6	37453 0	36377 1	38824 3	35596 3	40214 2	34832 5	41622 3	34085 2	43
18	36123 2	37162 2	37475 7	36364 0	38847 3	35583 5	40237 5	34820 0	41645 9	34072 9	42
19	36145 6	37148 7	37498 4	36350 8	38870 3	35570 6	40260 8	34807 4	41669 5	34060 6	41
20	36168 0	37135 3	37521 1	36337 7	38893 3	35557 7	40284 1	34794 8	41693 1	34048 3	40
21	36190 4	37121 8	37543 9	36324 6	38916 4	35544 9	40307 5	34782 2	41716 8	34036 0	39
22	36212 8	37108 4	37566 6	36311 4	38939 4	35532 0	40330 8	34769 6	41740 4	34023 7	38
23	36235 2	37095 0	37589 3	36298 3	38962 4	35519 2	40354 2	34757 1	41764 0	34011 4	37
24	36257 6	37081 5	37612 0	36285 2	38985 5	35506 4	40377 5	34744 5	41787 7	33999 1	36
25	36280 0	37068 1	37634 8	36272 0	39008 5	35493 5	40400 9	34732 0	41811 4	33986 8	35
26	36302 4	37054 7	37657 5	36258 9	39031 6	35480 7	40424 2	34719 4	41835 0	33974 5	34
27	36324 9	37041 3	37680 3	36245 8	39054 6	35467 9	40447 6	34706 9	41858 7	33962 2	33
28	36347 3	37027 9	37703 0	36232 7	39077 7	35455 0	40471 0	34694 3	41882 4	33949 9	32
29	36369 7	37014 5	37725 8	36219 6	39100 8	35442 2	40494 3	34681 8	41906 0	33937 7	31
30	36392 2	37001 1	37748 5	36206 5	39123 9	35429 4	40517 7	34669 2	41929 7	33925 4	30
31	36414 6	36987 7	37771 3	36193 4	39146 9	35416 6	40541 1	34656 7	41953 4	33913 1	29
32	36437 1	36974 3	37794 1	36180 3	39170 0	35403 8	40564 5	34644 2	41977 1	33900 9	28
33	36459 5	36960 9	37816 9	36167 2	39193 1	35391 0	40587 9	34631 7	42000 8	33888 6	27
34	36482 0	36947 6	37839 6	36154 2	39216 2	35378 2	40611 3	34619 2	42024 5	33876 4	26
35	36504 5	36934 2	37862 4	36141 1	39239 3	35365 4	40634 7	34606 6	42048 2	33864 1	25
36	36526 9	36920 8	37885 2	36128 0	39262 4	35352 6	40658 1	34594 1	42071 9	33851 9	24
37	36549 4	36907 5	37908 0	36114 9	39285 5	35339 9	40681 5	34581 6	42095 6	33839 7	23
38	36571 9	36894 1	37930 8	36101 9	39308 6	35327 1	40704 9	34569 1	42119 3	33827 4	22
39	36594 4	36880 8	37953 6	36088 8	39331 8	35314 3	40728 4	34556 6	42143 0	33815 2	21
40	36616 9	36867 4	37976 5	36075 8	39354 9	35301 6	40751 8	34544 2	42166 8	33803 0	20
41	36639 4	36854 1	37999 3	36062 7	39378 0	35288 8	40775 2	34531 7	42190 5	33790 8	19
42	36661 9	36840 7	38022 1	36049 7	39401 2	35276 0	40798 7	34519 2	42214 2	33778 6	18
43	36684 4	36827 4	38044 9	36036 7	39424 3	35263 3	40822 1	34506 7	42238 0	33766 3	17
44	36706 9	36814 1	38067 8	36023 6	39447 4	35250 6	40845 6	34494 2	42261 7	33754 1	16
45	36729 5	36800 8	38090 6	36010 6	39470 6	35237 8	40869 0	34481 8	42285 5	33741 9	15
46	36752 0	36787 5	38113 5	35997 6	39493 8	35225 1	40892 5	34469 3	42309 2	33729 7	14
47	36774 5	36774 1	38136 3	35984 6	39516 9	35212 3	40916 0	34456 9	42333 0	33717 5	13
48	36797 1	36760 8	38159 2	35971 6	39540 1	35199 6	40939 4	34444 4	42356 8	33705 4	12
49	36819 6	36747 5	38182 0	35958 6	39563 3	35186 9	40962 9	34432 0	42380 5	33693 2	11
50	36842 2	36734 2	38204 9	35945 6	39586 4	35174 2	40986 4	34419 5	42404 3	33681 0	10
51	36864 7	36721 0	38227 8	35932 6	39609 6	35161 5	41009 9	34407 1	42428 1	33668 8	9
52	36887 3	36707 7	38250 6	35919 6	39632 8	35148 8	41033 4	34394 6	42451 9	33656 7	8
53	36909 8	36694 4	38273 5	35906 6	39656 0	35136 1	41056 9	34382 2	42475 7	33644 5	7
54	36932 4	36681 1	38296 4	35893 6	39679 2	35123 4	41080 4	34369 8	42499 5	33632 3	6
55	36955 0	36667 8	38319 3	35880 6	39702 4	35110 7	41103 9	34357 4	42523 3	33620 2	5
56	36977 6	36654 6	38342 2	35867 6	39725 6	35098 0	41127 4	34344 9	42547 1	33608 0	4
57	37000 2	36641 3	38365 1	35854 7	39748 8	35085 3	41150 9	34332 5	42570 9	33595 9	3
58	37022 8	36628 1	38388 0	35841 7	39772 0	35072 6	41174 4	34320 1	42594 7	33583 7	2
59	37045 4	36614 8	38410 9	35828 8	39795 3	35059 9	41197 9	34307 7	42618 5	33571 6	1
60	37068 0	36601 6	38433 9	35815 8	39818 5	35047 3	41221 5	34295 3	42642 4	33559 4	0
	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	′
	39°	309°	38°	308°	37°	307°	36°	306°	35°	305°	

′	55°		56°		57°		58°		59°		
	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	
0	42642 4	33559 4	44080 7	32839 1	45536 1	32133 7	47008 1	31442 9	48496 2	30766 1	60
1	42666 2	33547 3	44104 8	32827 2	45560 5	32122 1	47032 7	31431 5	48521 1	30755 0	59
2	42690 0	33535 2	44129 0	32815 3	45584 9	32110 5	47057 4	31420 1	48546 1	30743 8	58
3	42713 9	33523 1	44153 1	32803 5	45609 3	32098 8	47082 1	31408 7	48571 0	30732 6	57
4	42737 7	33510 9	44177.2	32791 6	45633 7	32087 2	47106 8	31397 3	48596 0	30721 5	56
5	42761 6	33498 8	44201 3	32779 7	45658 1	32075 6	47131 5	31385 9	48620 9	30710 3	55
6	42785 4	33486 7	44225 5	32767 9	45682 6	32064 0	47156 2	31374 6	48645 9	30699 2	54
7	42809 3	33474 6	44249 6	32756 0	45707 0	32052 4	47180 9	31363 2	48670 8	30688 1	53
8	42833 1	33462 5	44273 8	32744 2	45731 4	32040 8	47205 6	31351 8	48695 8	30676 9	52
9	42857 0	33450 4	44297 9	32732 3	45755 8	32029 2	47230 3	31340 5	48720 8	30665 8	51
10	42880 9	33438 3	44322 1	32720 5	45780 3	32017 6	47255 0	31329 1	48745 7	30654 7	50
11	42904 8	33426 2	44346 3	32708 6	45804 7	32006 0	47279 7	31317 8	48770 7	30643 5	49
12	42928 6	33414 1	44370 4	32696 8	45829 2	31994 4	47304 4	31306 4	48795 7	30632 4	48
13	42952 5	33402 1	44394 6	32685 0	45853 6	31982 8	47329 1	31295 1	48820 7	30621 3	47
14	42976 4	33390 0	44418 8	32673 2	45878 1	31971 2	47353 9	31283 7	48845 7	30610 2	46
15	43000 3	33377 9	44443 0	32661 3	45902 5	31959 7	47378 6	31272 4	48870 7	30599 1	45
16	43024 2	33365 8	44467 2	32649 5	45927 0	31948 1	47403 3	31261 1	48895 7	30588 0	44
17	43048 1	33353 8	44491 4	32637 7	45951 5	31936 5	47428 1	31249 7	48920 7	30576 9	43
18	43072 0	33341 7	44515 6	32625 5	45976 0	31925 0	47452 8	31238 4	48945 7	30565 8	42
19	43096 0	33329 7	44539 8	32614 1	46000 4	31913 4	47477 6	31227 1	48970 7	30554 7	41
20	43119 9	33317 6	44564 0	32602 3	46024 9	31901 8	47502 3	31215 7	48995 7	30543 6	40
21	43143 8	33305 6	44588 2	32590 5	46049 4	31890 3	47527 1	31204 4	49020 8	30532 5	39
22	43167 7	33293 5	44612 4	32578 7	46073 9	31878 7	47551 9	31193 1	49045 8	30521 4	38
23	43191 7	33281 5	44636 6	32566 9	46098 4	31867 2	47576 6	31181 8	49070 8	30510 3	37
24	43215 6	33269 5	44660 8	32555 2	46122 9	31855 7	47601 4	31170 5	49095 9	30499 3	36
25	43239 6	33257 4	44685 1	32543 4	46147 4	31844 1	47626 2	31159 2	49120 9	30488 2	35
26	43263 5	33245 4	44709 3	32531 6	46171 9	31832 6	47651 0	31147 9	49145 9	30477 1	34
27	43287 5	33233 4	44733 6	32519 8	46196 5	31821 1	47675 8	31136 6	49171 0	30466 1	33
28	43311 4	33221 4	44757 8	32508 1	46221 0	31809 5	47700 5	31125 3	49196 0	30455 0	32
29	43335 4	33209 4	44782 0	32496 3	46245 5	31798 0	47725 3	31114 0	49221 1	30443 9	31
30	43359 4	33197 3	44806 3	32484 5	46270 0	31786 5	47750 1	31102 8	49246 2	30432 9	30
31	43383 4	33185 3	44830 6	32472 8	46294 6	31775 0	47774 9	31091 5	49271 2	30421 8	29
32	43407 3	33173 3	44854 8	32461 0	46319 1	31763 5	47799 8	31080 2	49296 3	30410 8	28
33	43431 3	33161 4	44879 1	32449 3	46343 7	31752 0	47824 6	31068 9	49321 4	30399 7	27
34	43455 3	33149 4	44903 4	32437 6	46368 2	31740 5	47849 4	31057 7	49346 4	30388 7	26
35	43479 3	33137 4	44927 6	32425 8	46392 8	31729 0	47874 2	31046 4	49371 5	30377 7	25
36	43503 3	33125 4	44951 9	32414 1	46417 3	31717 5	47899 0	31035 2	49396 6	30366 6	24
37	43527 3	33113 4	44976 2	32402 4	46441 9	31706 0	47923 9	31023 9	49421 7	30355 6	23
38	43551 3	33101 4	45000 5	32390 6	46466 4	31694 5	47948 7	31012 7	49446 8	30344 6	22
39	43575 3	33089 5	45024 8	32378 9	46491 0	31683 0	47973 5	31001 4	49471 9	30333 6	21
40	43599 3	33077 5	45049 1	32367 2	46515 6	31671 6	47998 4	30990 2	49497 0	30322 5	20
41	43623 4	33065 5	45073 4	32355 5	46540 2	31660 1	48023 2	30978 9	49522 1	30311 5	19
42	43647 4	33053 6	45097 7	32343 8	46564 8	31648 6	48048 1	30967 7	49547 2	30300 5	18
43	43671 4	33041 6	45122 0	32332 1	46589 3	31637 2	48072 9	30956 5	49572 3	30289 5	17
44	43695 5	33029 7	45146 4	32320 4	46613 9	31625 7	48097 8	30945 2	49597 5	30278 5	16
45	43719 5	33017 7	45170 7	32308 7	46638 5	31614 2	48122 7	30934 0	49622 6	30267 5	15
46	43743 6	33005 8	45195 0	32297 0	46663 1	31602 8	48147 5	30922 8	49647 7	30256 5	14
47	43767 6	32993 9	45219 3	32285 3	46687 8	31591 3	48172 4	30911 6	49672 9	30245 5	13
48	43791 7	32981 9	45243 7	32273 6	46712 4	31579 9	48197 3	30900 4	49698 0	30234 6	12
49	43815 7	32970 0	45268 0	32261 9	46737 0	31568 5	48222 2	30889 2	49723 1	30223 6	11
50	43839 8	32958 1	45292 4	32250 2	46761 6	31557 0	48247 1	30878 0	49748 3	30212 6	10
51	43863 9	32946 2	45316 7	32238 6	46786 2	31545 6	48272 0	30866 8	49773 4	30201 6	9
52	43887 9	32934 2	45341 1	32226 9	46810 9	31534 2	48296 9	30855 6	49798 6	30190 6	8
53	43912 0	32922 3	45365 4	32215 2	46835 5	31522 7	48321 8	30844 4	49823 8	30179 7	7
54	43936 1	32910 4	45389 8	32203 6	46860 1	31511 3	48346 7	30833 2	49848 9	30168 7	6
55	43960 2	32898 5	45414 2	32191 9	46884 8	31499 9	48371 6	30822 0	49874 1	30157 7	5
56	43984 3	32886 6	45438 5	32180 3	46909 4	31488 5	48396 5	30810 8	49899 3	30146 8	4
57	44008 4	32874 7	45462 9	32168 6	46934 1	31477 1	48421 4	30799 6	49924 4	30135 8	3
58	44032 5	32862 8	45487 3	32157 0	46958 7	31465 7	48446 3	30788 5	49949 6	30124 9	2
59	44056 6	32851 0	45511 7	32145 3	46983 4	31454 3	48471 3	30777 3	49974 8	30113 9	1
60	44080 7	32839 1	45536 1	32133 7	47008 1	31442 9	48496 2	30766 1	50000 0	30103 0	0
	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	′
	34°	304°	33°	303°	32°	302°	31°	301°	30°	300°	

′	60°		61°		62°		63°		64		
	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	
0	50000 0	30103 0	51519 0	29453 1	53052 8	28816 1	54600 9	28191 5	56162 9	27579 0	60
1	50025 2	30092 1	51544 5	29442 4	53078 5	28805 6	54626 9	28181 2	56189 9	27568 9	59
2	50050 4	30081 1	51569 9	29431 7	53104 2	28795 0	54652 8	28170 9	56215 2	27558 8	58
3	50075 6	30070 2	51595 4	29421 0	53129 9	28784 5	54678 7	28160 6	56241 3	27548 7	57
4	50100 8	30059 3	51620 8	29410 2	53155 6	28774 0	54704 6	28150 3	56267 5	27538 6	56
5	50126 0	30048 3	51646 3	29399 5	53181 3	28763 5	54730 6	28140 0	56293 7	27528 5	55
6	50151 2	30037 4	51671 8	29388 8	53207 0	28753 1	54756 5	28129 7	56319 8	27518 4	54
7	50176 4	30026 5	51697 2	29378 1	53232 7	28742 6	54782 5	28119 4	56346 0	27508 3	53
8	50201 7	30015 6	51722 7	29367 4	53258 4	28732 1	54808 4	28109 1	56372 2	27498 3	52
9	50226 9	30004 7	51748 2	29356 7	53284 2	28721 6	54834 4	28098 9	56398 3	27488 2	51
10	50252 1	29993 8	51773 7	29346 1	53309 9	28711 1	54860 3	28088 6	56424 5	27478 1	50
11	50277 4	29982 9	51799 1	29335 4	53335 6	28700 6	54886 3	28078 3	56450 7	27468 0	49
12	50302 6	29972 0	51824 6	29324 7	53361 3	28690 2	54912 2	28068 0	56476 9	27458 0	48
13	50327 8	29961 1	51850 1	29314 0	53387 1	28679 7	54938 2	28057 8	56503 1	27447 9	47
14	50353 1	29950 2	51875 6	29303 3	53412 8	28669 2	54964 2	28047 5	56529 3	27437 8	46
15	50378 3	29939 3	51901 1	29292 7	53438 5	28658 8	54990 2	28037 2	56555 5	27427 8	45
16	50403 6	29928 4	51926 6	29282 0	53464 3	28648 3	55016 1	28027 0	56581 7	27417 7	44
17	50428 9	29917 5	51952 1	29271 3	53490 0	28637 9	55042 1	28016 7	56607 9	27407 6	43
18	50454 1	29906 7	51977 6	29260 7	53515 8	28627 4	55068 1	28006 5	56634 1	27397 6	42
19	50479 4	29895 8	52003 2	29250 0	53541 5	28616 9	55094 1	27996 2	56660 3	27387 5	41
20	50504 7	29884 9	52028 7	29239 4	53567 3	28606 5	55120 1	27986 0	56686 5	27377 5	40
21	50529 9	29874 1	52054 2	29228 7	53593 1	28596 1	55146 1	27975 8	56712 7	27367 5	39
22	50555 2	29863 2	52079 7	29218 1	53618 8	28585 6	55172 1	27965 5	56739 0	27357 4	38
23	50580 5	29852 3	52105 3	29207 4	53644 6	28575 2	55198 1	27955 3	56765 2	27347 4	37
24	50605 8	29841 5	52130 8	29196 8	53670 4	28564 8	55224 1	27945 1	56791 4	27337 4	36
25	50631 1	29830 6	52156 4	29186 1	53696 2	28554 3	55250 1	27934 8	56817 7	27327 3	35
26	50656 4	29819 8	52181 9	29175 5	53722 0	28543 9	55276 1	27924 6	56843 9	27317 3	34
27	50681 7	29808 9	52207 4	29164 9	53747 7	28533 5	55302 1	27914 4	56870 1	27307 3	33
28	50707 0	29798 1	52233 0	29154 2	53773 5	28523 1	55328 2	27904 2	56896 4	27297 3	32
29	50732 3	29787 3	52258 6	29143 6	53799 3	28512 7	55354 2	27894 0	56922 6	27287 2	31
30	50757 6	29776 4	52284 1	29133 0	53825 1	28502 2	55380 2	27883 8	56948 9	27277 2	30
31	50783 0	29765 6	52309 7	29122 4	53850 9	28491 8	55406 2	27873 6	56975 1	27267 2	29
32	50808 3	29754 8	52335 3	29111 8	53876 7	28481 4	55432 3	27863 4	57001 4	27257 2	28
33	50833 6	29743 9	52360 8	29101 2	53902 6	28471 0	55458 3	27853 2	57027 7	27247 2	27
34	50858 9	29733 1	52386 4	29090 6	53928 4	28460 6	55484 4	27843 0	57053 9	27237 2	26
35	50884 3	29722 3	52412 0	29080 0	53954 2	28450 2	55510 4	27832 8	57080 2	27227 2	25
36	50909 6	29711 5	52437 6	29069 4	53980 0	28439 8	55536 5	27822 6	57106 5	27217 2	24
37	50935 0	29700 7	52463 2	29058 8	54005 8	28429 5	55562 5	27812 4	57132 8	27207 2	23
38	50960 3	29689 9	52488 8	29048 2	54031 7	28419 1	55588 6	27802 2	57159 0	27197 2	22
39	50985 7	29679 1	52514 4	29037 6	54057 5	28408 7	55614 7	27792 0	57185 3	27187 3	21
40	51011 0	29668 3	52540 0	29027 0	54083 3	28398 3	55640 7	27781 9	57211 6	27177 3	20
41	51036 4	29657 5	52565 6	29016 4	54109 2	28387 9	55666 8	27771 7	57237 9	27167 3	19
42	51061 7	29646 7	52591 2	29005 9	54135 0	28377 6	55692 9	27761 5	57264 2	27157 3	18
43	51087 1	29635 9	52616 8	28995 3	54160 9	28367 2	55719 0	27751 3	57290 5	27147 4	17
44	51112 5	29625 1	52642 4	28984 7	54186 7	28356 8	55745 0	27741 2	57316 8	27137 4	16
45	51137 9	29614 4	52668 0	28974 1	54212 6	28346 5	55771 1	27731 0	57343 1	27127 4	15
46	51163 3	29603 6	52693 7	28963 6	54238 5	28336 1	55797 2	27720 9	57369 4	27117 5	14
47	51188 6	29592 8	52719 3	28953 0	54264 3	28325 8	55823 3	27710 7	57395 7	27107 5	13
48	51214 0	29582 1	52744 9	28942 5	54290 2	28315 4	55849 4	27700 6	57422 1	27097 6	12
49	51239 4	29571 3	52770 6	28931 9	54316 1	28305 1	55875 5	27690 4	57448 4	27087 6	11
50	51264 8	29560 5	52796 2	28921 4	54342 0	28294 7	55901 6	27680 3	57474 7	27077 7	10
51	51290 2	29549 8	52821 8	28910 8	54367 8	28284 4	55927 7	27670 1	57501 0	27067 7	9
52	51315 6	29539 0	52847 5	28900 3	54393 7	28274 1	55953 8	27660 0	57527 4	27057 8	8
53	51341 0	29528 3	52873 1	28889 7	54419 6	28263 7	55980 0	27649 9	57553 7	27047 8	7
54	51366 5	29517 5	52898 8	28879 2	54445 5	28253 4	56006 1	27639 7	57580 1	27037 9	6
55	51391 9	29506 8	52924 5	28868 7	54471 4	28243 1	56032 2	27629 6	57606 4	27028 0	5
56	51417 3	29496 0	52950 1	28858 1	54497 3	28232 7	56058 3	27619 5	57632 7	27018 0	4
57	51442 7	29485 3	52975 8	28847 6	54523 2	28222 4	56084 5	27609 4	57659 1	27008 1	3
58	51468 2	29474 6	53001 5	28837 1	54549 1	28212 1	56110 6	27599 3	57685 4	26998 2	2
59	51493 6	29463 8	53027 2	28826 6	54575 0	28201 8	56136 7	27589 1	57711 8	26988 3	1
60	51519 0	29453 1	53052 8	28816 1	54600 9	28191 5	56162 9	27579 0	57738 2	26978 4	0
	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	′
	29°	299°	28°	298°	27°	297°	26°	296°	25°	295°	

′	65°		66°		67°		68°		69°		
	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	
0	57738 2	26978 3	59326 3	26389 1	60926 9	25811 1	62539 3	25243 8	64163 2	24687 2	60
1	57764 5	26968 4	59352 9	26379 4	60953 7	25801 5	62566 3	25234 5	64190 4	24678 0	59
2	57790 9	26958 5	59379 5	26369 7	60980 4	25792 0	62593 3	25225 1	64217 5	24668 8	58
3	57817 3	26948 6	59406 1	26360 0	61007 2	25782 4	62620 3	25215 8	64244 7	24659 6	57
4	57843 7	26938 7	59432 7	26350 2	61034 0	25772 9	62647 2	25206 4	64271 9	24650 5	56
5	57870 0	26928 8	59459 2	26340 5	61060 8	25763 4	62674 2	25197 0	64299 0	24641 3	55
6	57896 4	26918 9	59485 8	26330 8	61087 6	25753 8	62701 2	25187 7	64326 2	24632 1	54
7	57922 8	26909 0	59512 4	26321 1	61114 4	25744 3	62728 2	25178 4	64353 4	24622 9	53
8	57949 2	26899 1	59539 0	26311 4	61141 2	25734 8	62755 2	25169 0	64380 6	24613 8	52
9	57975 6	26889 2	59565 6	26301 7	61168 0	25725 3	62782 2	25159 7	64407 7	24604 6	51
10	58002 0	26879 4	59592 2	26292 0	61194 8	25715 8	62809 2	25150 3	64434 9	24595 4	50
11	58028 4	26869 5	59618 9	26282 3	61221 6	25706 3	62836 2	25141 0	64462 1	24586 3	49
12	58054 8	26859 6	59645 5	26272 6	61248 4	25696 7	62863 2	25131 7	64489 3	24577 1	48
13	58081 2	26849 7	59672 1	26262 9	61275 3	25687 2	62890 2	25122 3	64516 5	24568 0	47
14	58107 6	26839 8	59698 7	26253 3	61302 1	25677 7	62917 2	25113 0	64543 7	24558 8	46
15	58134 0	26830 0	59725 3	26243 6	61328 9	25668 2	62944 3	25103 7	64570 9	24549 7	45
16	58160 4	26820 1	59752 0	26233 9	61355 7	25658 7	62971 3	25094 4	64598 1	24540 5	44
17	58186 9	26810 2	59778 6	26224 2	61382 6	25649 2	62998 3	25085 1	64625 3	24531 4	43
18	58213 3	26800 4	59805 2	26214 5	61409 4	25639 8	63025 3	25075 7	64652 5	24522 2	42
19	58239 7	26790 5	59831 9	26204 9	61436 2	25630 3	63052 3	25066 4	64679 7	24513 1	41
20	58266 1	26780 7	59858 5	26195 2	61463 1	25620 8	63079 4	25057 1	64706 9	24504 0	40
21	58292 6	26770 8	59885 1	26185 5	61489 9	25611 3	63106 4	25047 8	64734 2	24494 8	39
22	58319 0	26761 0	59911 8	26175 9	61516 8	25601 8	63133 5	25038 5	64761 4	24485 7	38
23	58345 5	26751 1	59938 4	26166 2	61543 6	25592 3	63160 5	25029 2	64788 6	24476 6	37
24	58371 9	26741 3	59965 1	26156 6	61570 5	25582 9	63187 5	25019 9	64815 8	24467 4	36
25	58398 4	26731 5	59991 7	26146 9	61597 3	25573 4	63214 6	25010 6	64843 1	24458 3	35
26	58424 8	26721 6	60018 4	26137 3	61624 2	25563 9	63241 6	25001 3	64870 3	24449 2	34
27	58451 3	26711 8	60045 1	26127 6	61651 0	25554 5	63268 7	24992 1	64897 5	24440 1	33
28	58477 7	26702 0	60071 7	26118 0	61677 9	25545 0	63295 7	24982 8	64924 8	24431 0	32
29	58504 2	26692 1	60098 4	26108 3	61704 8	25535 6	63322 8	24973 5	64952 0	24421 9	31
30	58530 7	26682 3	60125 1	26098 7	61731 7	25526 1	63349 9	24964 2	64979 3	24412 8	30
31	58557 1	26672 5	60151 8	26089 1	61758 5	25516 7	63376 9	24954 9	65006 5	24403 7	29
32	58583 6	26662 7	60178 4	26079 4	61785 4	25507 2	63404 0	24945 7	65033 8	24394 6	28
33	58610 1	26652 9	60205 1	26069 8	61812 3	25497 8	63431 1	24936 4	65061 0	24385 5	27
34	58636 6	26643 1	60231 8	26060 2	61839 2	25488 3	63458 2	24927 1	65088 3	24376 4	26
35	58663 1	26633 3	60258 5	26050 6	61866 1	25478 9	63485 2	24917 9	65115 5	24367 3	25
36	58689 6	26623 5	60285 2	26041 0	61893 0	25469 4	63512 3	24908 6	65142 8	24358 2	24
37	58716 0	26613 7	60311 9	26031 3	61919 9	25460 0	63539 4	24899 3	65170 1	24349 1	23
38	58742 5	26603 9	60338 6	26021 7	61946 8	25450 6	63566 5	24890 1	65197 3	24340 0	22
39	58769 0	26594 1	60365 3	26012 1	61973 7	25441 1	63593 6	24880 8	65224 6	24330 9	21
40	58795 5	26584 3	60392 0	26002 5	62000 6	25431 7	63620 7	24871 6	65251 9	24321 8	20
41	58822 0	26574 5	60418 7	25992 9	62027 5	25422 3	63647 8	24862 3	65279 1	24312 8	19
42	58848 6	26564 7	60445 4	25983 3	62054 4	25412 9	63674 9	24853 1	65306 4	24303 7	18
43	58875 1	26554 9	60472 2	25973 7	62081 3	25403 5	63702 0	24843 9	65333 7	24294 6	17
44	58901 6	26545 1	60498 9	25964 1	62108 2	25394 0	63729 1	24834 6	65361 0	24285 6	16
45	58928 1	26535 4	60525 6	25954 5	62135 1	25384 6	63756 2	24825 4	65388 3	24276 5	15
46	58954 6	26525 6	60552 3	25945 0	62162 1	25375 2	63783 3	24816 1	65415 6	24267 4	14
47	58981 2	26515 8	60579 1	25935 4	62189 0	25365 8	63810 4	24806 9	65442 9	24258 4	13
48	59007 7	26506 1	60605 8	25925 8	62215 9	25356 4	63837 5	24797 7	65470 2	24249 3	12
49	59034 2	26496 3	60632 5	25916 2	62242 9	25347 0	63864 7	24788 5	65497 5	24240 3	11
50	59060 8	26486 5	60659 3	25906 6	62269 8	25337 6	63891 8	24779 2	65524 8	24231 2	10
51	59087 3	26476 8	60686 0	25897 1	62296 7	25328 2	63918 9	24770 0	65552 1	24222 2	9
52	59113 8	26467 0	60712 8	25887 5	62323 7	25318 8	63946 0	24760 8	65579 4	24213 1	8
53	59140 4	26457 3	60739 5	25877 9	62350 6	25309 5	63973 2	24751 6	65606 7	24204 1	7
54	59166 9	26447 5	60766 3	25868 4	62377 6	25300 1	64000 3	24742 4	65634 0	24195 0	6
55	59193 5	26437 8	60793 0	25858 8	62404 5	25290 7	64027 5	24733 2	65661 3	24186 0	5
56	59220 1	26428 1	60819 8	25849 2	62431 5	25281 3	64054 6	24724 0	65688 7	24177 0	4
57	59246 6	26418 3	60846 6	25839 7	62458 4	25271 9	64081 7	24714 8	65716 0	24167 9	3
58	59273 2	26408 6	60873 3	25830 1	62485 4	25262 6	64108 9	24705 6	65743 3	24158 9	2
59	59299 8	26398 9	60900 1	25820 6	62512 4	25253 2	64136 0	24696 4	65770 6	24149 9	1
60	59326 3	26389 1	60926 9	25811 1	62539 3	25243 8	64163 2	24687 2	65798 0	24140 9	0
	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	′
	24°	294°	23°	293°	22°	292°	21°	291°	20°	290°	

′	70°		71°		72°		73°		74°		
	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	
0	65798 0	24140 9	67443 2	23604 6	69098 3	23078 1	70762 8	22561 2	72436 3	22053 7	60
1	65825 3	24131 9	67470 7	23595 7	69126 0	23069 4	70790 6	22552 7	72464 2	22045 3	59
2	65852 7	24122 8	67498 2	23586 9	69153 6	23060 7	70818 5	22544 2	72492 2	22036 9	58
3	65880 0	24113 8	67525 7	23578 0	69181 3	23052 1	70846 3	22535 6	72520 2	22028 6	57
4	65907 3	24104 8	67553 2	23569 2	69209 0	23043 4	70874 1	22527 1	72548 1	22020 2	56
5	65934 7	24095 8	67580 7	23560 4	69236 7	23034 7	70901 9	22518 6	72576 1	22011 8	55
6	65962 0	24086 8	67608 3	23551 5	69264 3	23026 0	70929 8	22510 1	72604 1	22003 4	54
7	65989 4	24077 8	67635 8	23542 7	69292 0	23017 3	70957 6	22501 5	72632 1	21995 1	53
8	66016 7	24068 8	67663 3	23533 8	69319 7	23008 7	70985 4	22493 0	72660 0	21986 7	52
9	66044 1	24059 8	67690 8	23525 0	69347 4	23000 0	71013 3	22484 5	72688 0	21978 4	51
10	66071 5	24050 8	67718 4	23516 2	69375 1	22991 3	71041 1	22476 0	72716 0	21970 0	50
11	66098 8	24041 8	67745 9	23507 4	69402 8	22982 7	71069 0	22467 5	72744 0	21961 6	49
12	66126 2	24032 8	67773 4	23498 5	69430 5	22974 0	71096 8	22459 0	72772 0	21953 3	48
13	66153 6	24023 8	67801 0	23489 7	69458 2	22965 3	71124 7	22450 5	72800 0	21944 9	47
14	66180 9	24014 8	67828 5	23480 9	69485 9	22956 7	71152 5	22442 0	72828 0	21936 6	46
15	66208 3	24005 9	67856 0	23472 1	69513 6	22948 0	71180 4	22433 5	72856 0	21928 2	45
16	66235 7	23996 9	67883 6	23463 3	69541 3	22939 4	71208 2	22425 0	72883 9	21919 9	44
17	66263 1	23987 9	67911 1	23454 4	69569 0	22930 7	71236 1	22416 5	72911 9	21911 6	43
18	66290 5	23978 9	67938 7	23445 6	69596 7	22922 1	71263 9	22408 0	72940 0	21903 2	42
19	66317 9	23970 0	67966 3	23436 8	69624 4	22913 4	71291 8	22399 5	72968 0	21894 9	41
20	66345 2	23961 0	67993 8	23428 0	69652 1	22904 8	71319 7	22391 0	72996 0	21886 6	40
21	66372 6	23952 0	68021 4	23419 2	69679 8	22896 1	71347 5	22382 5	73024 0	21878 2	39
22	66400 0	23943 1	68048 9	23410 4	69707 6	22887 5	71375 4	22374 1	73052 0	21869 9	38
23	66427 4	23934 1	68076 5	23401 6	69735 3	22878 9	71403 3	22365 6	73080 0	21861 6	37
24	66454 8	23925 2	68104 1	23392 8	69763 0	22870 2	71431 2	22357 1	73108 0	21853 2	36
25	66482 2	23916 2	68131 6	23384 1	69790 7	22861 6	71459 0	22348 6	73136 0	21844 9	35
26	66509 7	23907 3	68159 2	23375 3	69818 5	22853 0	71486 9	22340 2	73164 1	21836 6	34
27	66537 1	23898 3	68186 8	23366 5	69846 2	22844 4	71514 8	22331 7	73192 1	21828 3	33
28	66564 5	23889 4	68214 4	23357 7	69874 0	22835 7	71542 7	22323 2	73220 1	21820 0	32
29	66591 9	23880 4	68241 9	23348 9	69901 7	22827 1	71570 6	22314 8	73248 1	21811 7	31
30	66619 3	23871 5	68269 5	23340 2	69929 4	22818 5	71598 5	22306 3	73276 2	21803 4	30
31	66646 7	23862 6	68297 1	23331 4	69957 2	22809 9	71626 4	22297 9	73304 2	21795 1	29
32	66674 2	23853 6	68324 7	23322 6	69984 9	22801 3	71654 2	22289 4	73332 2	21786 8	28
33	66701 6	23844 7	68352 3	23313 8	70012 7	22792 7	71682 1	22280 9	73360 3	21778 5	27
34	66729 0	23835 8	68379 9	23305 1	70040 4	22784 1	71710 0	22272 5	73388 3	21770 2	26
35	66756 4	23826 8	68407 5	23296 3	70068 2	22775 5	71737 9	22264 1	73416 3	21761 9	25
36	66783 9	23817 9	68435 1	23287 6	70095 9	22766 9	71765 8	22255 6	73444 4	21753 6	24
37	66811 3	23809 0	68462 7	23278 8	70123 7	22758 3	71793 8	22247 2	73472 4	21745 3	23
38	66838 8	23800 1	68490 3	23270 0	70151 4	22749 7	71821 7	22238 7	73500 5	21737 0	22
39	66866 2	23791 2	68517 9	23261 3	70179 2	22741 1	71849 6	22230 3	73528 5	21728 7	21
40	66893 7	23782 3	68545 5	23252 5	70207 0	22732 5	71877 5	22221 9	73556 6	21720 4	20
41	66921 1	23773 3	68573 1	23243 8	70234 7	22723 9	71905 4	22213 4	73584 6	21712 1	19
42	66948 6	23764 4	68600 7	23235 1	70262 5	22715 3	71933 3	22205 0	73612 7	21703 9	18
43	66976 0	23755 5	68628 4	23226 3	70290 3	22706 7	71961 2	22196 6	73640 7	21695 6	17
44	67003 5	23746 6	68656 0	23217 6	70318 1	22698 2	71989 2	22188 1	73668 8	21687 3	16
45	67030 9	23737 7	68683 6	23208 8	70345 8	22689 6	72017 1	22179 7	73696 9	21679 0	15
46	67058 4	23728 8	68711 2	23200 1	70373 6	22681 0	72045 0	22171 3	73724 9	21670 8	14
47	67085 9	23719 9	68738 9	23191 4	70401 4	22672 4	72073 0	22162 9	73753 0	21662 5	13
48	67113 3	23711 1	68766 5	23182 7	70429 2	22663 9	72100 9	22154 5	73781 1	21654 2	12
49	67140 8	23702 2	68794 1	23173 9	70457 0	22655 3	72128 8	22146 1	73809 1	21646 0	11
50	67168 3	23693 3	68821 8	23165 2	70484 8	22646 7	72156 8	22137 6	73837 2	21637 7	10
51	67195 8	23684 4	68849 4	23156 5	70512 6	22638 2	72184 7	22129 2	73865 3	21629 5	9
52	67223 2	23675 5	68877 1	23147 8	70540 4	22629 6	72212 6	22120 8	73893 4	21621 2	8
53	67250 7	23666 7	68904 7	23139 1	70568 2	22621 1	72240 6	22112 4	73921 5	21613 0	7
54	67278 2	23657 8	68932 4	23130 3	70596 0	22612 5	72268 5	22104 0	73949 5	21604 7	6
55	67305 7	23648 9	68960 0	23121 6	70623 8	22604 0	72296 5	22095 6	73977 6	21596 5	5
56	67333 2	23640 0	68987 7	23112 9	70651 6	22595 4	72324 4	22087 2	74005 7	21588 2	4
57	67360 7	23631 2	69015 3	23104 2	70679 4	22586 9	72352 4	22078 9	74033 8	21580 0	3
58	67388 2	23622 3	69043 0	23095 5	70707 2	22578 3	72380 3	22070 5	74061 9	21571 8	2
59	67415 7	23613 5	69070 6	23086 8	70735 0	22569 8	72408 3	22062 1	74090 0	21563 5	1
60	67443 2	23604 6	69098 3	23078 1	70762 8	22561 2	72436 3	22053 7	74118 1	21555 3	0
	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	′
	19°	289°	18°	288°	17°	287°	16°	286°	15°	285°	

′	75°		76°		77°		78°		79°		
	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	
0	74118 1	21555 3	75807 8	21065 8	77504 9	20585 0	79208 8	20112 8	80919 1	19648 9	60
1	74146 2	21547 1	75836 0	21057 7	77533 2	20577 1	79237 3	20105 0	80947 7	19641 3	59
2	74174 3	21538 8	75864 3	21049 6	77561 6	20569 2	79265 7	20097 2	80976 2	19633 6	58
3	74202 4	21530 6	75892 5	21041 6	77589 9	20561 2	79294 2	20089 4	81004 8	19626 0	57
4	74230 5	21522 4	75920 7	21033 5	77618 3	20553 3	79322 7	20081 6	81033 3	19618 3	56
5	74258 6	21514 2	75949 0	21025 4	77646 6	20545 4	79351 1	20073 8	81061 9	19610 7	55
6	74286 7	21505 9	75977 2	21017 3	77675 0	20537 4	79379 6	20066 1	81090 5	19603 0	54
7	74314 8	21497 7	76005 4	21009 3	77703 3	20529 5	79408 0	20058 3	81119 0	19595 4	53
8	74342 9	21489 5	76033 7	21001 2	77731 7	20521 6	79436 5	20050 5	81147 6	19587 7	52
9	74371 1	21481 3	76061 9	20993 1	77760 1	20513 7	79465 0	20042 7	81176 1	19580 1	51
10	74399 2	21473 1	76090 2	20985 1	77788 4	20505 8	79493 4	20034 9	81204 7	19572 4	50
11	74427 3	21464 9	76118 4	20977 0	77816 8	20497 8	79521 9	20027 2	81233 3	19564 8	49
12	74455 4	21456 7	76146 6	20969 0	77845 1	20489 9	79550 4	20019 4	81261 9	19557 2	48
13	74483 5	21448 5	76174 9	20960 9	77873 5	20482 0	79578 9	20011 6	81290 4	19549 5	47
14	74511 7	21440 3	76203 2	20952 9	77901 9	20474 1	79607 3	20003 8	81319 0	19541 9	46
15	74539 8	21432 1	76231 4	20944 8	77930 3	20466 2	79635 8	19996 1	81347 6	19534 3	45
16	74567 9	21423 9	76259 7	20936 8	77958 6	20458 3	79664 3	19988 3	81376 2	19526 6	44
17	74596 1	21415 7	76287 9	20928 7	77987 0	20450 4	79692 8	19980 5	81404 8	19519 0	43
18	74624 2	21407 5	76316 2	20920 7	78015 4	20442 5	79721 3	19972 8	81433 3	19511 4	42
19	74652 3	21399 3	76344 4	20912 6	78043 8	20434 6	79749 8	19965 0	81461 9	19503 8	41
20	74680 5	21391 1	76372 7	20904 6	78072 1	20426 7	79778 2	19957 3	81490 5	19496 1	40
21	74708 6	21383 0	76401 0	20896 6	78100 5	20418 8	79806 7	19949 5	81519 1	19488 5	39
22	74736 8	21374 8	76429 2	20888 5	78128 9	20410 9	79835 2	19941 8	81547 7	19480 9	38
23	74764 9	21366 6	76457 5	20880 5	78157 3	20403 0	79863 7	19934 0	81576 3	19473 3	37
24	74793 1	21358 4	76485 8	20872 5	78185 7	20395 1	79892 2	19926 3	81604 9	19465 7	36
25	74821 2	21350 3	76514 1	20864 4	78214 1	20387 3	79920 7	19918 5	81633 5	19458 1	35
26	74849 4	21342 1	76542 3	20856 4	78242 5	20379 4	79949 2	19910 8	81662 0	19450 5	34
27	74877 5	21333 9	76570 6	20848 4	78270 8	20371 5	79977 7	19903 1	81690 6	19442 9	33
28	74905 7	21325 8	76598 9	20840 4	78299 2	20363 6	80006 2	19895 3	81719 2	19435 3	32
29	74933 8	21317 6	76627 2	20832 4	78327 6	20355 7	80034 7	19887 6	81747 8	19427 7	31
30	74962 0	21309 4	76655 5	20824 3	78356 0	20347 9	80063 2	19879 9	81776 4	19420 1	30
31	74990 2	21301 3	76683 7	20816 3	78384 4	20340 0	80091 7	19872 1	81805 0	19412 5	29
32	75018 3	21293 1	76712 0	20808 3	78412 8	20332 1	80120 2	19864 4	81833 6	19404 9	28
33	75046 5	21285 0	76740 3	20800 3	78441 2	20324 3	80148 7	19856 7	81862 3	19397 3	27
34	75074 7	21276 8	76768 6	20792 3	78469 6	20316 4	80177 2	19848 9	81890 9	19389 7	26
35	75102 8	21268 7	76796 9	20784 3	78498 1	20308 6	80205 7	19841 2	81919 5	19382 1	25
36	75131 0	21260 5	76825 2	20776 3	78526 5	20300 7	80234 3	19833 5	81948 1	19374 6	24
37	75159 2	21252 4	76853 5	20768 3	78554 9	20292 8	80262 8	19825 8	81976 7	19367 0	23
38	75187 4	21244 3	76881 8	20760 3	78583 3	20285 0	80291 3	19818 1	82005 3	19359 4	22
39	75215 5	21236 1	76910 1	20752 3	78611 7	20277 1	80319 8	19810 4	82033 9	19351 8	21
40	75243 7	21228 0	76938 4	20744 3	78640 1	20269 3	80348 3	19802 7	82062 5	19344 3	20
41	75271 9	21219 9	76966 7	20736 4	78668 5	20261 4	80376 9	19794 9	82091 2	19336 7	19
42	75300 1	21211 7	76995 0	20728 4	78697 0	20253 6	80405 4	19787 2	82119 8	19329 1	18
43	75328 3	21203 6	77023 3	20720 4	78725 4	20245 8	80433 9	19779 5	82148 4	19321 5	17
44	75356 5	21195 5	77051 6	20712 4	78753 8	20237 9	80462 4	19771 8	82177 0	19314 0	16
45	75384 7	21187 3	77080 0	20704 4	78782 2	20230 1	80491 0	19764 1	82205 6	19306 4	15
46	75412 9	21179 2	77108 3	20696 5	78810 7	20222 3	80519 5	19756 4	82234 3	19298 9	14
47	75441 1	21171 1	77136 6	20688 5	78839 1	20214 4	80548 0	19748 8	82262 9	19291 3	13
48	75469 3	21163 0	77164 9	20680 5	78867 5	20206 6	80576 6	19741 1	82291 5	19283 7	12
49	75497 5	21154 9	77193 2	20672 5	78896 0	20198 8	80605 1	19733 4	82320 2	19276 2	11
50	75525 7	21146 8	77221 6	20664 6	78924 4	20190 9	80633 6	19725 7	82348 8	19268 6	10
51	75553 9	21138 7	77249 9	20656 6	78952 8	20183 1	80662 2	19718 0	82377 4	19261 1	9
52	75582 1	21130 6	77278 2	20648 6	78981 3	20175 3	80690 7	19710 3	82406 0	19253 5	8
53	75610 3	21122 5	77306 5	20640 7	79009 7	20167 5	80719 3	19702 6	82434 7	19246 0	7
54	75638 5	21114 4	77334 9	20632 7	79038 1	20159 7	80747 8	19695 0	82463 3	19238 5	6
55	75666 7	21106 3	77363 2	20624 8	79066 6	20151 8	80776 3	19687 3	82492 0	19230 9	5
56	75694 9	21098 2	77391 5	20616 8	79095 0	20144 0	80804 9	19679 6	82520 6	19223 4	4
57	75723 1	21090 1	77419 9	20608 9	79123 5	20136 2	80833 4	19671 9	82549 2	19215 8	3
58	75751 4	21082 0	77448 2	20600 9	79151 9	20128 4	80862 0	19664 3	82577 9	19208 3	2
59	75779 6	21073 9	77476 5	20593 0	79180 4	20120 6	80890 5	19656 6	82606 5	19200 8	1
60	75807 8	21065 8	77504 9	20585 0	79208 8	20112 8	80919 1	19648 9	82635 2	19193 3	0
	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	′
	14°	284°	13°	283°	12°	282°	11°	281°	10°	280°	

′	80°		81°		82°		83°		84°		
	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	
0	82635 2	19193 3	84356 5	18745 6	86082 7	18305 7	87813 1	17873 5	89547 1	17448 9	60
1	82663 8	19185 7	84385 3	18738 2	86111 5	18298 4	87841 9	17866 4	89576 1	17441 9	59
2	82692 5	19178 2	84414 0	18730 8	86140 3	18291 2	87870 8	17859 3	89605 0	17434 9	58
3	82721 1	19170 7	84442 7	18723 4	86169 1	18283 9	87899 7	17852 1	89633 9	17427 9	57
4	82749 8	19163 2	84471 5	18716 0	86197 9	18276 7	87928 6	17845 0	89662 9	17420 9	56
5	82778 4	19155 6	84500 2	18708 6	86226 7	18269 4	87957 4	17837 9	89691 8	17413 9	55
6	82807 1	19148 1	84529 0	18701 2	86255 5	18262 1	87986 3	17830 7	89720 7	17406 9	54
7	82835 7	19140 6	84557 7	18693 8	86284 4	18254 9	88015 2	17823 6	89749 7	17399 9	53
8	82864 4	19133 1	84586 4	18686 5	86313 2	18247 6	88044 1	17816 5	89778 6	17392 9	52
9	82893 1	19125 6	84615 2	18679 1	86342 0	18240 4	88073 0	17809 4	89807 5	17385 9	51
10	82921 7	19118 1	84643 9	18671 7	86370 8	18233 2	88101 8	17802 3	89836 5	17378 9	50
11	82950 4	19110 6	84672 7	18664 3	86399 6	18225 9	88130 7	17795 1	89865 4	17371 9	49
12	82979 0	19103 1	84701 4	18657 0	86428 4	18218 7	88159 6	17788 0	89894 4	17364 9	48
13	83007 7	19095 6	84730 2	18649 6	86457 3	18211 4	88188 5	17780 9	89923 3	17357 9	47
14	83036 4	19088 1	84758 9	18642 2	86486 1	18204 2	88217 4	17773 8	89952 2	17350 9	46
15	83065 0	19080 6	84787 7	18634 9	86514 9	18197 0	88246 3	17766 7	89981 2	17343 9	45
16	83093 7	19073 1	84816 4	18627 5	86543 7	18189 7	88275 1	17759 6	90010 1	17336 9	44
17	83122 4	19065 6	84845 2	18620 1	86572 6	18182 5	88304 0	17752 5	90039 1	17329 9	43
18	83151 1	19058 1	84873 9	18612 8	86601 4	18175 3	88332 9	17745 4	90068 0	17323 0	42
19	83179 7	19050 6	84902 7	18605 4	86630 2	18168 0	88361 8	17738 3	90097 0	17316 0	41
20	83208 4	19043 1	84931 4	18598 1	86659 0	18160 8	88390 7	17731 2	90125 9	17309 0	40
21	83237 1	19035 7	84960 2	18590 7	86687 9	18153 6	88419 6	17724 1	90154 9	17302 0	39
22	83265 8	19028 2	84988 9	18583 4	86716 7	18146 4	88448 5	17717 0	90183 8	17295 1	38
23	83294 4	19020 7	85017 7	18576 0	86745 5	18139 1	88477 4	17709 9	90212 8	17288 1	37
24	83323 1	19013 2	85046 5	18568 7	86774 4	18131 9	88506 3	17702 8	90241 7	17281 1	36
25	83351 8	19005 7	85075 2	18561 3	86803 2	18124 7	88535 2	17695 7	90270 7	17274 2	35
26	83380 5	18998 3	85104 0	18554 0	86832 0	18117 5	88564 1	17688 6	90299 6	17267 2	34
27	83409 2	18990 8	85132 8	18546 7	86860 9	18110 3	88593 0	17681 5	90328 6	17260 2	33
28	83437 9	18983 3	85161 5	18539 3	86889 7	18103 1	88621 9	17674 5	90357 5	17253 3	32
29	83466 5	18975 9	85190 3	18532 0	86918 5	18095 9	88650 8	17667 4	90386 5	17246 3	31
30	83495 2	18968 4	85219 1	18524 7	86947 4	18088 7	88679 7	17660 3	90415 4	17239 4	30
31	83523 9	18961 0	85247 8	18517 3	86976 2	18081 5	88708 6	17653 2	90444 4	17232 4	29
32	83552 6	18953 5	85276 6	18510 0	87005 1	18074 3	88737 5	17646 1	90473 3	17225 5	28
33	83581 3	18946 0	85305 4	18502 7	87033 9	18067 1	88766 4	17639 1	90502 3	17218 5	27
34	83610 0	18938 6	85334 1	18495 4	87062 7	18059 9	88795 3	17632 0	90531 2	17211 6	26
35	83638 7	18931 1	85362 9	18488 0	87091 6	18052 7	88824 2	17624 9	90560 2	17204 6	25
36	83667 4	18923 7	85391 7	18480 7	87120 4	18045 5	88853 1	17617 9	90589 2	17197 7	24
37	83696 1	18916 2	85420 5	18473 4	87149 3	18038 3	88882 0	17610 8	90618 1	17190 7	23
38	83724 8	18908 8	85449 2	18466 1	87178 1	18031 1	88910 9	17603 7	90647 1	17183 8	22
39	83753 5	18901 4	85478 0	18458 8	87207 0	18023 9	88939 8	17596 7	90676 0	17176 9	21
40	83782 2	18893 9	85506 8	18451 5	87235 8	18016 8	88968 7	17589 6	90705 0	17169 9	20
41	83810 9	18886 5	85535 6	18444 2	87264 7	18009 6	88997 7	17582 6	90734 0	17163 0	19
42	83839 6	18879 0	85564 4	18436 8	87293 5	18002 4	89026 6	17575 5	90762 9	17156 1	18
43	83868 3	18871 6	85593 2	18429 5	87322 4	17995 2	89055 5	17568 5	90791 9	17149 1	17
44	83897 0	18864 2	85621 9	18422 2	87351 2	17988 0	89084 4	17561 4	90820 9	17142 2	16
45	83925 7	18856 7	85650 7	18414 9	87380 1	17980 9	89113 3	17554 4	90849 8	17135 3	15
46	83954 4	18849 3	85679 5	18407 6	87409 0	17973 7	89142 2	17547 3	90878 8	17128 4	14
47	83983 2	18841 9	85708 3	18400 4	87437 8	17966 5	89171 1	17540 3	90907 8	17121 4	13
48	84011 9	18834 5	85737 1	18393 1	87466 7	17959 4	89200 1	17533 2	90936 7	17114 5	12
49	84040 6	18827 0	85765 9	18385 8	87495 5	17952 2	89229 0	17526 2	90965 7	17107 6	11
50	84069 3	18819 6	85794 7	18378 5	87524 4	17945 0	89257 9	17519 2	90994 7	17100 7	10
51	84098 0	18812 2	85823 5	18371 2	87553 3	17937 9	89286 8	17512 1	91023 6	17093 8	9
52	84126 7	18804 8	85852 3	18363 9	87582 1	17930 7	89315 7	17505 1	91052 6	17086 9	8
53	84155 5	18797 4	85881 1	18356 6	87611 0	17923 6	89344 7	17498 1	91081 6	17080 0	7
54	84184 2	18790 0	85909 9	18349 3	87639 8	17916 4	89373 6	17491 0	91110 6	17073 1	6
55	84212 9	18782 6	85938 7	18342 1	87668 7	17909 3	89402 5	17484 0	91139 5	17066 2	5
56	84241 6	18775 2	85967 5	18334 8	87697 6	17902 1	89431 4	17477 0	91168 5	17059 3	4
57	84270 4	18767 8	85996 3	18327 5	87726 4	17895 0	89460 4	17470 0	91197 5	17052 4	3
58	84299 1	18760 4	86025 1	18320 2	87755 3	17887 8	89489 3	17462 9	91226 5	17045 5	2
59	84327 8	18753 0	86053 9	18313 0	87784 2	17880 7	89518 2	17455 9	91255 4	17038 6	1
60	84356 5	18745 6	86082 7	18305 7	87813 1	17873 5	89547 1	17448 9	91284 4	17031 7	0
	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	′
	9°	279°	8°	278°	7°	277°	6°	276°	5°	275°	

′	85°		86°		87°		88°		89°		
	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	Sum or Diff.	Hour Angle	
0	91284 4	17031 7	93024 3	16621 7	94766 4	16218 8	96510 1	15822 9	98254 8	15433 8	60
1	91313 4	17024 8	93053 4	16614 9	94795 4	16212 1	96539 1	15816 3	98283 8	15427 4	59
2	91342 4	17017 9	93082 4	16608 1	94824 5	16205 5	96568 2	15809 8	98312 9	15421 0	58
3	91371 4	17011 0	93111 4	16601 4	94853 5	16198 8	96597 3	15803 3	98342 0	15414 5	57
4	91400 3	17004 1	93140 4	16594 6	94882 6	16192 2	96626 3	15796 7	98371 1	15408 1	56
5	91429 3	16997 2	93169 4	16587 8	94911 6	16185 5	96655 4	15790 2	98400 2	15401 7	55
6	91458 3	16990 3	93198 5	16581 1	94940 7	16178 9	96684 5	15783 7	98429 3	15395 3	54
7	91487 3	16983 5	93227 5	16574 3	94969 8	16172 2	96713 6	15777 1	98458 3	15388 9	53
8	91516 3	16976 6	93256 5	16567 5	94998 8	16165 6	96742 6	15770 6	98487 4	15382 5	52
9	91545 3	16969 7	93285 5	16560 8	95027 9	16159 0	96771 7	15764 1	98516 5	15376 0	51
10	91574 2	16962 8	93314 6	16554 0	95056 9	16152 3	96800 8	15757 6	98545 6	15369 6	50
11	91603 2	16956 0	93343 6	16547 3	95086 0	16145 7	96829 8	15751 0	98574 7	15363 2	49
12	91632 2	16949 1	93372 6	16540 5	95115 0	16139 0	96858 9	15744 5	98603 8	15356 8	48
13	91661 2	16942 2	93401 6	16533 8	95144 1	16132 4	96888 0	15738 0	98632 9	15350 4	47
14	91690 2	16935 4	93430 7	16527 0	95173 1	16125 8	96917 1	15731 5	98661 9	15344 0	46
15	91719 2	16928 5	93459 7	16520 3	95202 2	16119 2	96946 1	15725 0	98691 0	15337 6	45
16	91748 2	16921 6	93488 7	16513 5	95231 2	16112 5	96975 2	15718 5	98720 1	15331 2	44
17	91777 2	16914 8	93517 7	16506 8	95260 3	16105 9	97004 3	15712 0	98749 2	15324 8	43
18	91806 1	16907 9	93546 8	16500 1	95289 3	16099 3	97033 4	15705 4	98778 3	15318 4	42
19	91835 1	16901 1	93575 8	16493 3	95318 4	16092 7	97062 4	15698 9	98807 4	15312 0	41
20	91864 1	16894 2	93604 8	16486 6	95347 5	16086 0	97091 5	15692 4	98836 5	15305 6	40
21	91893 1	16887 3	93633 9	16479 9	95376 5	16079 4	97120 6	15685 9	98865 6	15299 2	39
22	91922 1	16880 5	93662 9	16473 1	95405 6	16072 8	97149 7	15679 4	98894 6	15292 9	38
23	91951 1	16873 6	93691 9	16466 4	95434 6	16066 2	97178 8	15672 9	98923 7	15286 5	37
24	91980 1	16866 8	93720 9	16459 7	95463 7	16059 6	97207 8	15666 4	98952 8	15280 1	36
25	92009 1	16860 0	93750 0	16452 9	95492 8	16053 0	97236 9	15659 9	98981 9	15273 7	35
26	92038 1	16853 1	93779 0	16446 2	95521 8	16046 4	97266 0	15653 4	99011 0	15267 3	34
27	92067 1	16846 3	93808 0	16439 5	95550 9	16039 8	97295 1	15647 0	99040 1	15260 9	33
28	92096 1	16839 4	93837 1	16432 8	95579 9	16033 2	97324 1	15640 5	99069 2	15254 6	32
29	92125 1	16832 6	93866 1	16426 1	95609 0	16026 6	97353 2	15634 0	99098 3	15248 2	31
30	92154 1	16825 8	93895 1	16419 3	95638 1	16020 0	97382 3	15627 5	99127 3	15241 8	30
31	92183 1	16818 9	93924 2	16412 6	95667 1	16013 4	97411 4	15621 0	99156 4	15235 4	29
32	92212 1	16812 1	93953 2	16405 9	95696 2	16006 8	97440 5	15614 5	99185 5	15229 1	28
33	92241 1	16805 3	93982 2	16399 2	95725 2	16000 2	97469 5	15608 1	99214 6	15222 7	27
34	92270 1	16798 5	94011 3	16392 5	95754 3	15993 6	97498 6	15601 6	99243 7	15216 4	26
35	92299 1	16791 6	94040 3	16385 8	95783 4	15987 0	97527 7	15595 1	99272 8	15210 0	25
36	92328 1	16784 8	94069 4	16379 1	95812 4	15980 4	97556 8	15588 6	99301 9	15203 6	24
37	92357 1	16778 0	94098 4	16372 4	95841 5	15973 8	97585 9	15582 2	99331 0	15197 3	23
38	92386 1	16771 2	94127 4	16365 7	95870 6	15967 2	97614 9	15575 7	99360 0	15190 9	22
39	92415 1	16764 3	94156 5	16359 0	95899 6	15960 7	97644 0	15569 2	99389 1	15184 5	21
40	92444 1	16757 5	94185 5	16352 3	95928 7	15954 1	97673 1	15562 8	99418 2	15178 2	20
41	92473 1	16750 7	94214 6	16345 6	95957 8	15947 5	97702 2	15556 3	99447 3	15171 8	19
42	92502 1	16743 9	94243 6	16338 9	95986 8	15940 9	97731 3	15549 8	99476 4	15165 5	18
43	92531 1	16737 1	94272 6	16332 2	96015 9	15934 3	97760 3	15543 4	99505 5	15159 1	17
44	92560 1	16730 3	94301 7	16325 5	96044 9	15927 8	97789 4	15536 9	99534 6	15152 8	16
45	92589 1	16723 5	94330 7	16318 8	96074 0	15921 2	97818 5	15530 4	99563 7	15146 5	15
46	92618 2	16716 7	94359 8	16312 2	96103 1	15914 6	97847 6	15524 0	99592 8	15140 1	14
47	92647 2	16709 9	94388 8	16305 5	96132 1	15908 1	97876 7	15517 5	99621 8	15133 8	13
48	92676 2	16703 1	94417 8	16298 8	96161 2	15901 5	97905 8	15511 1	99650 9	15127 4	12
49	92705 2	16696 3	94446 9	16292 1	96190 3	15894 9	97934 8	15504 6	99680 0	15121 1	11
50	92734 2	16689 5	94475 9	16285 4	96219 3	15888 4	97963 9	15498 2	99709 1	15114 8	10
51	92763 2	16682 7	94505 0	16278 8	96248 4	15881 8	97993 0	15491 7	99738 2	15108 4	9
52	92792 2	16675 9	94534 0	16272 1	96277 5	15875 3	98022 1	15485 3	99767 3	15102 1	8
53	92821 2	16669 1	94563 1	16265 4	96306 6	15868 7	98051 2	15478 9	99796 4	15095 8	7
54	92850 3	16662 3	94592 1	16258 8	96335 6	15862 2	98080 3	15472 4	99825 5	15089 4	6
55	92879 3	16655 6	94621 2	16252 1	96364 7	15855 6	98109 3	15466 0	99854 6	15083 1	5
56	92908 3	16648 8	94650 2	16245 4	96393 8	15849 1	98138 4	15459 5	99883 6	15076 8	4
57	92937 3	16642 0	94679 3	16238 8	96422 8	15842 5	98167 5	15453 1	99912 7	15070 5	3
58	92966 3	16635 2	94708 3	16232 1	96451 9	15836 0	98196 6	15446 7	99941 8	15064 1	2
59	92995 3	16628 4	94737 4	16225 4	96481 0	15829 4	98225 7	15440 2	99970 9	15057 8	1
60	93024 3	16621 7	94766 4	16218 8	96510 1	15822 9	98254 8	15433 8	100000 0	15051 5	0
	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	Alt.	Hour Angle	′
	4°	274°	3°	273°	2°	272°	1°	271°	0°	270°	

′	Hour Angle										
	90°	91°	92°	93°	94°	95°	96°	97°	98°	99°	
0	15051 5	14675 8	14306 6	13943 8	13587 3	13236 9	12892 7	12554 4	12222 0	11895 4	60
1	15045 2	14669 6	14300 5	13937 8	13581 4	13231 1	12887 0	12548 8	12216 5	11890 1	59
2	15038 9	14663 4	14294 4	13931 8	13575 5	13225 3	12881 3	12543 2	12211 0	11884 7	58
3	15032 6	14657 2	14288 3	13925 8	13569 6	13219 6	12875 6	12537 6	12205 5	11879 3	57
4	15026 2	14651 0	14282 2	13919 8	13563 7	13213 8	12869 9	12532 0	12200 1	11873 9	56
5	15019 9	14644 8	14276 1	13913 8	13557 8	13208 0	12864 2	12526 5	12194 6	11868 5	55
6	15013 6	14638 6	14270 0	13907 8	13551 9	13202 2	12858 6	12520 9	12189 1	11863 1	54
7	15007 3	14632 4	14263 9	13901 9	13546 1	13196 4	12852 9	12515 3	12183 6	11857 7	53
8	15001 0	14626 2	14257 8	13895 9	13540 2	13190 7	12847 2	12509 7	12178 1	11852 3	52
9	14994 7	14620 0	14251 8	13889 9	13534 3	13184 9	12841 5	12504 2	12172 7	11847 0	51
10	14988 4	14613 8	14245 7	13883 9	13528 4	13179 1	12835 9	12498 6	12167 2	11841 6	50
11	14982 1	14607 6	14239 6	13877 9	13522 6	13173 3	12830 2	12493 0	12161 7	11836 2	49
12	14975 8	14601 4	14233 5	13872 0	13516 7	13167 6	12824 5	12487 4	12156 2	11830 8	48
13	14969 5	14595 3	14227 4	13866 0	13510 8	13161 8	12818 9	12481 9	12150 8	11825 4	47
14	14963 2	14589 1	14221 4	13860 0	13505 0	13156 0	12813 2	12476 3	12145 3	11820 1	46
15	14957 0	14582 9	14215 3	13854 1	13499 1	13150 3	12807 5	12470 7	12139 8	11814 7	45
16	14950 7	14576 7	14209 2	13848 1	13493 2	13144 5	12801 9	12465 2	12134 4	11809 3	44
17	14944 4	14570 5	14203 2	13842 1	13487 4	13138 8	12796 2	12459 6	12128 9	11804 0	43
18	14938 1	14564 4	14197 1	13836 2	13481 5	13133 0	12790 5	12454 1	12123 4	11798 6	42
19	14931 8	14558 2	14191 0	13830 2	13475 6	13127 2	12784 9	12448 5	12118 0	11793 2	41
20	14925 5	14552 0	14184 9	13824 2	13469 8	13121 5	12779 2	12442 9	12112 5	11787 9	40
21	14919 3	14545 8	14178 9	13818 3	13463 9	13115 7	12773 6	12437 4	12107 1	11782 5	39
22	14913 0	14539 7	14172 8	13812 3	13458 1	13110 0	12767 9	12431 8	12101 6	11777 1	38
23	14906 7	14533 5	14166 8	13806 4	13452 2	13104 2	12762 3	12426 3	12096 1	11771 8	37
24	14900 4	14527 3	14160 7	13800 4	13446 4	13098 5	12756 6	12420 7	12090 7	11766 4	36
25	14894 2	14521 2	14154 6	13794 5	13440 5	13092 7	12751 0	12415 2	12085 2	11761 1	35
26	14887 9	14515 0	14148 6	13788 5	13434 7	13087 0	12745 3	12409 6	12079 8	11755 7	34
27	14881 6	14508 9	14142 5	13782 6	13428 8	13081 2	12739 7	12404 1	12074 3	11750 4	33
28	14875 4	14502 7	14136 5	13776 6	13423 0	13075 5	12734 1	12398 6	12068 9	11745 0	32
29	14869 1	14496 5	14130 4	13770 7	13417 2	13069 8	12728 4	12393 0	12063 5	11739 7	31
30	14862 8	14490 4	14124 4	13764 7	13411 3	13064 0	12722 8	12387 5	12058 0	11734 3	30
31	14856 6	14484 2	14118 3	13758 8	13405 5	13058 3	12717 1	12381 9	12052 6	11729 0	29
32	14850 3	14478 1	14112 3	13752 9	13399 6	13052 6	12711 5	12376 4	12047 1	11723 6	28
33	14844 1	14471 9	14106 3	13746 9	13393 8	13046 8	12705 9	12370 9	12041 7	11718 3	27
34	14837 8	14465 8	14100 2	13741 0	13388 0	13041 1	12700 2	12365 3	12036 3	11712 9	26
35	14831 5	14459 6	14094 2	13735 0	13382 1	13035 4	12694 6	12359 8	12030 8	11707 6	25
36	14825 3	14453 5	14088 1	13729 1	13376 3	13029 6	12689 0	12354 3	12025 4	11702 3	24
37	14819 0	14447 4	14082 1	13723 2	13370 5	13023 9	12683 4	12348 7	12020 0	11696 9	23
38	14812 8	14441 2	14076 1	13717 3	13364 7	13018 2	12677 7	12343 2	12014 5	11691 6	22
39	14806 6	14435 1	14070 0	13711 3	13358 8	13012 5	12672 1	12337 7	12009 1	11686 3	21
40	14800 3	14428 9	14064 0	13705 4	13353 0	13006 7	12666 5	12332 2	12003 7	11680 9	20
41	14794 1	14422 8	14058 0	13699 5	13347 2	13001 0	12660 9	12326 6	11998 2	11675 6	19
42	14787 8	14416 7	14052 0	13693 6	13341 4	12995 3	12655 2	12321 1	11992 8	11670 3	18
43	14781 6	14410 6	14045 9	13687 6	13335 6	12989 6	12649 6	12315 6	11987 4	11664 9	17
44	14775 3	14404 4	14039 9	13681 7	13329 7	12983 9	12644 0	12310 1	11982 0	11659 6	16
45	14769 1	14398 3	14033 9	13675 8	13323 9	12978 2	12638 4	12304 6	11976 6	11654 3	15
46	14762 9	14392 2	14027 9	13669 9	13318 1	12972 4	12632 8	12299 0	11971 1	11649 0	14
47	14756 6	14386 0	14021 9	13664 0	13312 3	12966 7	12627 2	12293 5	11965 7	11643 6	13
48	14750 4	14379 9	14015 8	13658 1	13306 5	12961 0	12621 6	12288 0	11960 3	11638 3	12
49	14744 2	14373 8	14009 8	13652 2	13300 7	12955 3	12616 0	12282 5	11954 9	11633 0	11
50	14738 0	14367 7	14003 8	13646 2	13294 9	12949 6	12610 4	12277 0	11949 5	11627 7	10
51	14731 7	14361 6	13997 8	13640 3	13289 1	12943 9	12604 7	12271 5	11944 1	11622 4	9
52	14725 5	14355 4	13991 8	13634 4	13283 3	12938 2	12599 1	12266 0	11938 7	11617 1	8
53	14719 3	14349 3	13985 8	13628 5	13277 5	12932 5	12593 5	12260 5	11933 3	11611 7	7
54	14713 1	14343 2	13979 8	13622 6	13271 7	12926 8	12587 9	12255 0	11927 8	11606 4	6
55	14706 9	14337 1	13973 8	13616 7	13265 9	12921 1	12582 3	12249 5	11922 4	11601 1	5
56	14700 6	14331 0	13967 8	13610 8	13260 1	12915 4	12576 8	12244 0	11917 0	11595 8	4
57	14694 4	14324 9	13961 8	13604 9	13254 3	12909 7	12571 2	12238 5	11911 6	11590 5	3
58	14688 2	14318 8	13955 8	13599 0	13248 5	12904 0	12565 6	12233 0	11906 2	11585 2	2
59	14682 0	14312 7	13949 8	13593 1	13242 7	12898 3	12560 0	12227 5	11900 8	11579 9	1
60	14675 8	14306 6	13943 8	13587 3	13236 9	12892 7	12554 4	12222 0	11895 4	11574 6	0
	269°	268°	267°	266°	265°	264°	263°	262°	261°	260°	′
	Hour Angle										

′	Hour Angle										
	100°	101°	102°	103°	104°	105°	106°	107°	108°	109°	
0	11574 6	11259 4	10949 7	10645 6	10346 8	10053 3	9765 1	9482 1	9204 2	8931 4	60
1	11569 3	11254 2	10944 6	10640 5	10341 9	10048 5	9760 4	9477 5	9199 7	8926 9	59
2	11564 0	11249 0	10939 5	10635 5	10336 9	10043 6	9755 6	9472 8	9195 1	8922 4	58
3	11558 7	11243 8	10934 4	10630 5	10332 0	10038 8	9750 9	9468 1	9190 5	8917 9	57
4	11553 4	11238 6	10929 3	10625 5	10327 1	10034 0	9746 1	9463 4	9185 9	8913 4	56
5	11548 1	11233 4	10924 2	10620 5	10322 1	10029 1	9741 4	9458 8	9181 3	8908 9	55
6	11542 8	11228 2	10919 1	10615 4	10317 2	10024 3	9736 6	9454 1	9176 7	8904 4	54
7	11537 5	11223 0	10914 0	10610 4	10312 3	10019 4	9731 9	9449 4	9172 1	8899 9	53
8	11532 3	11217 8	10908 9	10605 4	10307 4	10014 6	9727 1	9444 8	9167 6	8895 4	52
9	11527 0	11212 6	10903 8	10600 4	10302 4	10009 8	9722 4	9440 1	9163 0	8890 9	51
10	11521 7	11207 4	10898 7	10595 4	10297 5	10004 9	9717 6	9435 5	9158 4	8886 4	50
11	11516 4	11202 2	10893 6	10590 4	10292 6	10000 1	9712 9	9430 8	9153 8	8881 9	49
12	11511 1	11197 0	10888 5	10585 4	10287 7	9995 3	9708 1	9426 1	9149 3	8877 4	48
13	11505 8	11191 8	10883 4	10580 4	10282 8	9990 4	9703 4	9421 5	9144 7	8872 9	47
14	11500 6	11186 6	10878 3	10575 4	10277 8	9985 6	9698 6	9416 8	9140 1	8868 5	46
15	11495 3	11181 5	10873 2	10570 4	10272 9	9980 8	9693 9	9412 2	9135 6	8864 0	45
16	11490 0	11176 3	10868 1	10565 4	10268 0	9976 0	9689 2	9407 5	9131 0	8859 5	44
17	11484 7	11171 1	10863 0	10560 4	10263 1	9971 1	9684 4	9402 9	9126 4	8855 0	43
18	11479 5	11165 9	10857 9	10555 4	10258 2	9966 3	9679 7	9398 2	9121 9	8850 5	42
19	11474 2	11160 7	10852 8	10550 4	10253 3	9961 5	9675 0	9393 6	9117 3	8846 0	41
20	11468 9	11155 6	10847 7	10545 4	10248 4	9956 7	9670 2	9388 9	9112 7	8841 6	40
21	11463 6	11150 4	10842 7	10540 4	10243 5	9951 9	9665 5	9384 3	9108 2	8837 1	39
22	11458 4	11145 2	10837 6	10535 4	10238 6	9947 1	9660 8	9379 6	9103 6	8832 6	38
23	11453 1	11140 0	10832 5	10530 4	10233 7	9942 2	9656 0	9375 0	9099 1	8828 1	37
24	11447 8	11134 9	10827 4	10525 4	10228 8	9937 4	9651 3	9370 4	9094 5	8823 7	36
25	11442 6	11129 7	10822 3	10520 4	10223 9	9932 6	9646 6	9365 7	9089 9	8819 2	35
26	11437 3	11124 5	10817 3	10515 4	10219 0	9927 8	9641 9	9361 1	9085 4	8814 7	34
27	11432 1	11119 4	10812 2	10510 4	10214 1	9923 0	9637 1	9356 4	9080 8	8810 3	33
28	11426 8	11114 2	10807 1	10505 5	10209 2	9918 2	9632 4	9351 8	9076 3	8805 8	32
29	11421 6	11109 0	10802 0	10500 5	10204 3	9913 4	9627 7	9347 2	9071 7	8801 3	31
30	11416 3	11103 9	10797 0	10495 5	10199 4	9908 6	9623 0	9342 5	9067 2	8796 9	30
31	11411 0	11098 7	10791 9	10490 5	10194 5	9903 8	9618 3	9337 9	9062 6	8792 4	29
32	11405 8	11093 6	10786 8	10485 5	10189 6	9899 0	9613 6	9333 3	9058 1	8787 9	28
33	11400 5	11088 4	10781 8	10480 6	10184 7	9894 2	9608 8	9328 7	9053 6	8783 5	27
34	11395 3	11083 2	10776 7	10475 6	10179 8	9889 4	9604 1	9324 0	9049 0	8779 0	26
35	11390 1	11078 1	10771 6	10470 6	10175 0	9884 6	9599 4	9319 4	9044 5	8774 6	25
36	11384 8	11072 9	10766 6	10465 7	10170 1	9879 8	9594 7	9314 8	9039 9	8770 1	24
37	11379 6	11067 8	10761 5	10460 7	10165 2	9875 0	9590 0	9310 2	9035 4	8765 6	23
38	11374 3	11062 6	10756 5	10455 7	10160 3	9870 2	9585 3	9305 5	9030 9	8761 2	22
39	11369 1	11057 5	10751 4	10450 7	10155 4	9865 4	9580 6	9300 9	9026 3	8756 7	21
40	11363 8	11052 3	10746 4	10445 8	10150 6	9860 6	9575 9	9296 3	9021 8	8752 3	20
41	11358 6	11047 2	10741 3	10440 8	10145 7	9855 8	9571 2	9291 7	9017 3	8747 8	19
42	11353 4	11042 1	10736 2	10435 9	10140 8	9851 0	9566 5	9287 1	9012 7	8743 4	18
43	11348 1	11036 9	10731 2	10430 9	10135 9	9846 3	9561 8	9282 5	9008 2	8738 9	17
44	11342 9	11031 8	10726 1	10425 9	10131 1	9841 5	9557 1	9277 8	9003 7	8734 5	16
45	11337 7	11026 6	10721 1	10421 0	10126 2	9836 7	9552 4	9273 2	8999 1	8730 0	15
46	11332 4	11021 5	10716 1	10416 0	10121 3	9831 9	9547 7	9268 6	8994 6	8725 6	14
47	11327 2	11016 4	10711 0	10411 1	10116 5	9827 1	9543 0	9264 0	8990 1	8721 2	13
48	11322 0	11011 2	10706 0	10406 1	10111 6	9822 4	9538 3	9259 4	8985 6	8716 7	12
49	11316 8	11006 1	10700 9	10401 2	10106 7	9817 6	9533 6	9254 8	8981 0	8712 3	11
50	11311 5	11001 0	10695 9	10396 2	10101 9	9812 8	9528 9	9250 2	8976 5	8707 8	10
51	11306 3	10995 8	10690 8	10391 3	10097 0	9808 0	9524 3	9245 6	8972 0	8703 4	9
52	11301 1	10990 7	10685 8	10386 3	10092 2	9803 3	9519 6	9241 0	8967 5	8699 0	8
53	11295 9	10985 6	10680 8	10381 4	10087 3	9798 5	9514 9	9236 4	8963 0	8694 5	7
54	11290 7	10980 5	10675 7	10376 4	10082 4	9793 7	9510 2	9231 8	8958 5	8690 1	6
55	11285 4	10975 3	10670 7	10371 5	10077 6	9789 0	9505 5	9227 2	8953 9	8685 7	5
56	11280 2	10970 2	10665 7	10366 5	10072 7	9784 2	9500 8	9222 6	8949 4	8681 3	4
57	11275 0	10965 1	10660 6	10361 6	10067 9	9779 4	9496 2	9218 0	8944 9	8676 8	3
58	11269 8	10960 0	10655 6	10356 7	10063 0	9774 7	9491 5	9213 4	8940 4	8672 4	2
59	11264 6	10954 9	10650 6	10351 7	10058 2	9769 9	9486 8	9208 8	8935 9	8668 0	1
60	11259 4	10949 7	10645 6	10346 8	10053 3	9765 1	9482 1	9204 2	8931 4	8663 5	0
	259°	258°	257°	256°	255°	254°	253°	252°	251°	250°	′
	Hour Angle										

′	Hour Angle										
	110°	111°	112°	113°	114°	115°	116°	117°	118°	119°	
0	8663 5	8400 6	8142 6	7889 3	7640 9	7397 1	7158 0	6923 4	6693 4	6468 0	60
1	8659 1	8396 3	8138 3	7885 2	7636 8	7393 1	7154 0	6919 6	6689 6	6464 2	59
2	8654 7	8392 0	8134 1	7881 0	7632 7	7389 0	7150 1	6915 7	6685 9	6460 5	58
3	8650 3	8387 6	8129 8	7876 8	7628 6	7385 0	7146 1	6911 8	6682 1	6456 8	57
4	8645 9	8383 3	8125 5	7872 6	7624 5	7381 0	7142 2	6907 9	6678 3	6453 1	56
5	8641 5	8378 9	8121 3	7868 5	7620 4	7377 0	7138 2	6904 1	6674 5	6449 4	55
6	8637 0	8374 6	8117 0	7864 3	7616 3	7373 0	7134 3	6900 2	6670 7	6445 7	54
7	8632 6	8370 3	8112 8	7860 1	7612 2	7368 9	7130 4	6896 4	6666 9	6441 9	53
8	8628 2	8365 9	8108 5	7855 9	7608 1	7364 9	7126 4	6892 5	6663 1	6438 2	52
9	8623 8	8361 6	8104 3	7851 8	7604 0	7360 9	7122 5	6888 6	6659 3	6434 5	51
10	8619 4	8357 3	8100 0	7847 6	7599 9	7356 9	7118 5	6884 8	6655 5	6430 8	50
11	8615 0	8353 0	8095 8	7843 4	7595 8	7352 9	7114 6	6880 9	6651 8	6427 1	49
12	8610 6	8348 6	8091 5	7839 3	7591 7	7348 9	7110 7	6877 1	6648 0	6423 4	48
13	8606 2	8344 3	8087 3	7835 1	7587 6	7344 9	7106 8	6873 2	6644 2	6419 7	47
14	8601 8	8340 0	8083 1	7830 9	7583 6	7340 9	7102 8	6869 4	6640 4	6416 0	46
15	8597 4	8335 7	8078 8	7826 8	7579 5	7336 9	7098 9	6865 5	6636 7	6412 3	45
16	8593 0	8331 3	8074 6	7822 6	7575 4	7332 9	7095 0	6861 7	6632 9	6408 6	44
17	8588 6	8327 0	8070 3	7818 5	7571 3	7328 9	7091 0	6857 8	6629 1	6404 9	43
18	8584 2	8322 7	8066 1	7814 3	7567 2	7324 9	7087 1	6854 0	6625 3	6401 2	42
19	8579 8	8318 4	8061 9	7810 1	7563 2	7320 9	7083 2	6850 1	6621 6	6397 5	41
20	8575 4	8314 1	8057 6	7806 0	7559 1	7316 9	7079 3	6846 3	6617 8	6393 8	40
21	8571 0	8309 8	8053 4	7801 8	7555 0	7312 9	7075 4	6842 4	6614 0	6390 1	39
22	8566 6	8305 4	8049 2	7797 7	7550 9	7308 9	7071 4	6838 6	6610 2	6386 4	38
23	8562 2	8301 1	8044 9	7793 5	7546 9	7304 9	7067 5	6834 7	6606 5	6382 7	37
24	8557 8	8296 8	8040 7	7789 4	7542 8	7300 9	7063 6	6830 9	6602 7	6379 0	36
25	8553 4	8292 5	8036 5	7785 2	7538 7	7296 9	7059 7	6827 0	6598 9	6375 3	35
26	8549 0	8288 2	8032 3	7781 1	7534 6	7292 9	7055 8	6823 2	6595 2	6371 6	34
27	8544 6	8283 9	8028 0	7776 9	7530 6	7288 9	7051 9	6819 4	6591 4	6368 0	33
28	8540 2	8279 6	8023 8	7772 8	7526 5	7284 9	7047 9	6815 5	6587 7	6364 3	32
29	8535 9	8275 3	8019 6	7768 7	7522 4	7280 9	7044 0	6811 7	6583 9	6360 6	31
30	8531 5	8271 0	8015 4	7764 5	7518 4	7276 9	7040 1	6807 9	6580 1	6356 9	30
31	8527 1	8266 7	8011 1	7760 4	7514 3	7273 0	7036 2	6804 0	6576 4	6353 2	29
32	8522 7	8262 4	8006 9	7756 2	7510 3	7269 0	7032 3	6800 2	6572 6	6349 5	28
33	8518 3	8258 1	8002 7	7752 1	7506 2	7265 0	7028 4	6796 4	6568 9	6345 8	27
34	8514 0	8253 8	7998 5	7748 0	7502 1	7261 0	7024 5	6792 5	6565 1	6342 2	26
35	8509 6	8249 5	7994 3	7743 8	7498 1	7257 0	7020 6	6788 7	6561 4	6338 5	25
36	8505 2	8245 2	7990 1	7739 7	7494 0	7253 0	7016 7	6784 9	6557 6	6334 8	24
37	8500 8	8240 9	7985 9	7735 6	7490 0	7249 1	7012 8	6781 1	6553 9	6331 1	23
38	8496 5	8236 6	7981 6	7731 4	7485 9	7245 1	7008 9	6777 2	6550 1	6327 5	22
39	8492 1	8232 4	7977 4	7727 3	7481 9	7241 1	7005 0	6773 4	6546 4	6323 8	21
40	8487 7	8228 1	7973 2	7723 2	7477 8	7237 1	7001 1	6769 6	6542 6	6320 1	20
41	8483 4	8223 8	7969 0	7719 0	7473 8	7233 2	6997 2	6765 8	6538 9	6316 4	19
42	8479 0	8219 5	7964 8	7714 9	7469 7	7229 2	6993 3	6762 0	6535 1	6312 8	18
43	8474 6	8215 2	7960 6	7710 8	7465 7	7225 2	6989 4	6758 1	6531 4	6309 1	17
44	8470 3	8210 9	7956 4	7706 7	7461 6	7221 3	6985 5	6754 3	6527 7	6305 4	16
45	8465 9	8206 6	7952 2	7702 5	7457 6	7217 3	6981 6	6750 5	6523 9	6301 8	15
46	8461 5	8202 4	7948 0	7698 4	7453 5	7213 3	6977 7	6746 7	6520 2	6298 1	14
47	8457 2	8198 1	7943 8	7694 3	7449 5	7209 4	6973 9	6742 9	6516 4	6294 4	13
48	8452 8	8193 8	7939 6	7690 2	7445 5	7205 4	6970 0	6739 1	6512 7	6290 8	12
49	8448 5	8189 5	7935 4	7686 1	7441 4	7201 5	6966 1	6735 3	6509 0	6287 1	11
50	8444 1	8185 3	7931 2	7681 9	7437 4	7197 5	6962 2	6731 5	6505 2	6283 5	10
51	8439 8	8181 0	7927 0	7677 8	7433 3	7193 5	6958 3	6727 6	6501 5	6279 8	9
52	8435 4	8176 7	7922 8	7673 7	7429 3	7189 6	6954 4	6723 8	6497 8	6276 2	8
53	8431 1	8172 4	7918 6	7669 6	7425 3	7185 6	6950 6	6720 0	6494 0	6272 5	7
54	8426 7	8168 2	7914 4	7665 5	7421 2	7181 7	6946 7	6716 2	6490 3	6268 8	6
55	8422 4	8163 9	7910 3	7661 4	7417 2	7177 7	6942 8	6712 4	6486 6	6265 2	5
56	8418 0	8159 6	7906 1	7657 3	7413 2	7173 7	6938 9	6708 6	6482 9	6261 5	4
57	8413 7	8155 4	7901 9	7653 2	7409 2	7169 8	6935 0	6704 8	6479 1	6257 9	3
58	8409 3	8151 1	7897 7	7649 1	7405 1	7165 8	6931 2	6701 0	6475 4	6254 2	2
59	8405 0	8146 8	7893 5	7645 0	7401 1	7161 9	6927 3	6697 2	6471 7	6250 6	1
60	8400 6	8142 6	7889 3	7640 9	7397 1	7158 0	6923 4	6693 4	6468 0	6246 9	0
	249°	248°	247°	246°	245°	244°	243°	242°	241°	240°	
	Hour Angle										′

′	Hour Angle										
	120°	121°	122°	123°	124°	125°	126°	127°	128°	129°	
0	6246 9	6030 3	5818 1	5610 1	5406 5	5207 1	5011 9	4820 9	4634 0	4451 2	60
1	6243 3	6026 7	5814 6	5606 7	5403 1	5203 8	5008 7	4817 7	4630 9	4448 2	59
2	6239 6	6023 2	5811 1	5603 3	5399 8	5200 5	5005 5	4814 6	4627 8	4445 2	58
3	6236 0	6019 6	5807 6	5599 9	5396 4	5197 2	5002 3	4811 4	4624 7	4442 1	57
4	6232 4	6016 0	5804 1	5596 4	5393 1	5194 0	4999 0	4808 3	4621 7	4439 1	56
5	6228 7	6012 5	5800 6	5593 0	5389 7	5190 7	4995 8	4805 1	4618 6	4436 1	55
6	6225 1	6008 9	5797 1	5589 6	5386 4	5187 4	4992 6	4802 0	4615 5	4433 1	54
7	6221 4	6005 3	5793 6	5586 2	5383 0	5184 1	4989 4	4798 9	4612 4	4430 1	53
8	6217 8	6001 8	5790 1	5582 8	5379 7	5180 8	4986 2	4795 7	4609 4	4427 1	52
9	6214 2	5998 2	5786 6	5579 3	5376 3	5177 6	4983 0	4792 6	4606 3	4424 1	51
10	6210 5	5994 6	5783 1	5575 9	5373 0	5174 3	4979 8	4789 4	4603 2	4421 1	50
11	6206 9	5991 1	5779 6	5572 5	5369 6	5171 0	4976 6	4786 3	4600 2	4418 1	49
12	6203 3	5987 5	5776 1	5569 1	5366 3	5167 7	4973 4	4783 2	4597 1	4415 1	48
13	6199 6	5984 0	5772 7	5565 7	5362 9	5164 5	4970 2	4780 0	4594 0	4412 1	47
14	6196 0	5980 4	5769 2	5562 3	5359 6	5161 2	4967 0	4776 9	4591 0	4409 1	46
15	6192 4	5976 9	5765 7	5558 8	5356 3	5157 9	4963 8	4773 8	4587 9	4406 1	45
16	6188 7	5973 3	5762 2	5555 4	5352 9	5154 6	4960 6	4770 6	4584 8	4403 1	44
17	6185 1	5969 7	5758 7	5552 0	5349 6	5151 4	4957 4	4767 5	4581 8	4400 1	43
18	6181 5	5966 2	5755 2	5548 6	5346 2	5148 1	4954 2	4764 4	4578 7	4397 1	42
19	6177 9	5962 6	5751 8	5545 2	5342 9	5144 8	4951 0	4761 3	4575 7	4394 1	41
20	6174 2	5959 1	5748 3	5541 8	5339 6	5141 6	4947 8	4758 1	4572 6	4391 1	40
21	6170 6	5955 5	5744 8	5538 4	5336 2	5138 3	4944 6	4755 0	4569 5	4388 2	39
22	6167 0	5952 0	5741 3	5535 0	5332 9	5135 0	4941 4	4751 9	4566 5	4385 2	38
23	6163 4	5948 4	5737 9	5531 6	5329 6	5131 8	4938 2	4748 8	4563 4	4382 2	37
24	6159 8	5944 9	5734 4	5528 2	5326 2	5128 5	4935 0	4745 6	4560 4	4379 2	36
25	6156 1	5941 4	5730 9	5524 8	5322 9	5125 3	4931 8	4742 5	4557 3	4376 2	35
26	6152 5	5937 8	5727 4	5521 4	5319 6	5122 0	4928 6	4739 4	4554 3	4373 2	34
27	6148 9	5934 3	5724 0	5518 0	5316 3	5118 8	4925 4	4736 3	4551 2	4370 2	33
28	6145 3	5930 7	5720 5	5514 6	5312 9	5115 5	4922 2	4733 1	4548 2	4367 3	32
29	6141 7	5927 2	5717 0	5511 2	5309 6	5112 2	4919 1	4730 0	4545 1	4364 3	31
30	6138 1	5923 7	5713 6	5507 8	5306 3	5109 0	4915 9	4726 9	4542 1	4361 3	30
31	6134 5	5920 1	5710 1	5504 4	5303 0	5105 7	4912 7	4723 8	4539 0	4358 3	29
32	6130 9	5916 6	5706 6	5501 0	5299 6	5102 5	4909 5	4720 7	4536 0	4355 3	28
33	6127 3	5913 0	5703 2	5497 6	5296 3	5099 2	4906 3	4717 6	4532 9	4352 4	27
34	6123 7	5909 5	5699 7	5494 2	5293 0	5096 0	4903 2	4714 5	4529 9	4349 4	26
35	6120 0	5906 0	5696 3	5490 8	5289 7	5092 7	4900 0	4711 4	4526 8	4346 4	25
36	6116 4	5902 5	5692 8	5487 5	5286 4	5089 5	4896 8	4708 2	4523 8	4343 4	24
37	6112 8	5898 9	5689 3	5484 1	5283 0	5086 2	4893 6	4705 1	4520 8	4340 5	23
38	6109 2	5895 4	5685 9	5480 7	5279 7	5083 0	4890 4	4702 0	4517 7	4337 5	22
39	6105 6	5891 9	5682 4	5477 3	5276 4	5079 8	4887 3	4698 9	4514 7	4334 5	21
40	6102 0	5888 3	5679 0	5473 9	5273 1	5076 5	4884 1	4695 8	4511 7	4331 6	20
41	6098 4	5884 8	5675 5	5470 5	5269 8	5073 3	4880 9	4692 7	4508 6	4328 6	19
42	6094 8	5881 3	5672 1	5467 2	5266 5	5070 0	4877 8	4689 6	4505 6	4325 6	18
43	6091 3	5877 8	5668 6	5463 8	5263 2	5066 8	4874 6	4686 5	4502 6	4322 7	17
44	6087 7	5874 2	5665 2	5460 4	5259 9	5063 6	4871 4	4683 4	4499 5	4319 7	16
45	6084 1	5870 7	5661 7	5457 0	5256 6	5060 3	4868 3	4680 3	4496 5	4316 7	15
46	6080 5	5867 2	5658 3	5453 6	5253 3	5057 1	4865 1	4677 2	4493 5	4313 8	14
47	6076 9	5863 7	5654 8	5450 3	5250 0	5053 8	4861 9	4674 1	4490 4	4310 8	13
48	6073 3	5860 2	5651 4	5446 9	5246 7	5050 6	4858 8	4671 0	4487 4	4307 9	12
49	6069 7	5856 7	5647 9	5443 5	5243 3	5047 4	4855 6	4667 9	4484 4	4304 9	11
50	6066 1	5853 1	5644 5	5440 2	5240 0	5044 2	4852 4	4664 8	4481 4	4301 9	10
51	6062 5	5849 6	5641 1	5436 8	5236 7	5040 9	4849 3	4661 8	4478 3	4299 0	9
52	6059 0	5846 1	5637 6	5433 4	5233 5	5037 7	4846 1	4658 7	4475 3	4296 0	8
53	6055 4	5842 6	5634 2	5430 0	5230 2	5034 5	4843 0	4655 6	4472 3	4293 1	7
54	6051 8	5839 1	5630 7	5426 7	5226 9	5031 2	4839 8	4652 5	4469 3	4290 1	6
55	6048 2	5835 6	5627 3	5423 3	5223 6	5028 0	4836 6	4649 4	4466 3	4287 2	5
56	6044 6	5832 1	5623 9	5420 0	5220 3	5024 8	4833 5	4646 3	4463 2	4284 2	4
57	6041 0	5828 6	5620 4	5416 6	5217 0	5021 6	4830 3	4643 2	4460 2	4281 3	3
58	6037 5	5825 1	5617 0	5413 2	5213 7	5018 4	4827 2	4640 1	4457 2	4278 3	2
59	6033 9	5821 6	5613 6	5409 9	5210 4	5015 1	4824 0	4637 1	4454 2	4275 4	1
60	6030 3	5818 1	5610 1	5406 5	5207 1	5011 9	4820 9	4634 0	4451 2	4272 4	0
	239°	238°	237°	236°	235°	234°	233°	232°	231°	230°	′
	Hour Angle										

′	Hour Angle										
	130°	131°	132°	133°	134°	135°	136°	137°	138°	139°	
0	4272 4	4097 7	3927 0	3760 2	3597 4	3438 5	3283 4	3132 2	2984 8	2841 2	60
1	4269 5	4094 8	3924 2	3757 5	3594 7	3435 8	3280 9	3129 7	2982 4	2838 9	59
2	4266 5	4092 0	3921 4	3754 7	3592 0	3433 2	3278 3	3127 2	2980 0	2836 5	58
3	4263 6	4089 1	3918 6	3752 0	3589 4	3430 6	3275 8	3124 8	2977 6	2834 2	57
4	4260 7	4086 2	3915 7	3749 2	3586 7	3428 0	3273 2	3122 3	2975 1	2831 8	56
5	4257 7	4083 3	3912 9	3746 5	3584 0	3425 4	3270 7	3119 8	2972 7	2829 4	55
6	4254 8	4080 5	3910 1	3743 8	3581 3	3422 8	3268 1	3117 3	2970 3	2827 1	54
7	4251 8	4077 6	3907 3	3741 0	3578 6	3420 2	3265 6	3114 8	2967 9	2824 7	53
8	4248 9	4074 7	3904 5	3738 3	3576 0	3417 6	3263 0	3112 3	2965 5	2822 4	52
9	4246 0	4071 8	3901 7	3735 5	3573 3	3415 0	3260 5	3109 9	2963 0	2820 0	51
10	4243 0	4069 0	3898 9	3732 8	3570 6	3412 4	3257 9	3107 4	2960 6	2817 7	50
11	4240 1	4066 1	3896 1	3730 1	3568 0	3409 8	3255 4	3104 9	2958 2	2815 3	49
12	4237 2	4063 2	3893 3	3727 3	3565 3	3407 1	3252 9	3102 4	2955 8	2813 0	48
13	4234 2	4060 4	3890 5	3724 6	3562 6	3404 5	3250 3	3100 0	2953 4	2810 6	47
14	4231 3	4057 5	3887 7	3721 9	3560 0	3401 9	3247 8	3097 5	2951 0	2808 3	46
15	4228 4	4054 7	3884 9	3719 1	3557 3	3399 3	3245 3	3095 0	2948 6	2805 9	45
16	4225 4	4051 8	3882 1	3716 4	3554 6	3396 7	3242 7	3092 5	2946 2	2803 6	44
17	4222 5	4048 9	3879 3	3713 7	3552 0	3394 1	3240 2	3090 1	2943 8	2801 2	43
18	4219 6	4046 1	3876 5	3711 0	3549 3	3391 5	3237 6	3087 6	2941 4	2798 9	42
19	4216 7	4043 2	3873 7	3708 2	3546 6	3389 0	3235 1	3085 1	2938 9	2796 6	41
20	4213 7	4040 4	3871 0	3705 5	3544 0	3386 4	3232 6	3082 7	2936 5	2794 2	40
21	4210 8	4037 5	3868 2	3702 8	3541 3	3383 8	3230 1	3080 2	2934 1	2791 9	39
22	4207 9	4034 6	3865 4	3700 1	3538 7	3381 2	3227 5	3077 7	2931 7	2789 5	38
23	4205 0	4031 8	3862 6	3697 3	3536 0	3378 6	3225 0	3075 3	2929 3	2787 2	37
24	4202 1	4028 9	3859 8	3694 6	3533 4	3376 0	3222 5	3072 8	2926 9	2784 9	36
25	4199 1	4026 1	3857 0	3691 9	3530 7	3373 4	3219 9	3070 3	2924 5	2782 5	35
26	4196 2	4023 2	3854 2	3689 2	3528 0	3370 8	3217 4	3067 9	2922 1	2780 2	34
27	4193 3	4020 4	3851 5	3686 5	3525 4	3368 2	3214 9	3065 4	2919 7	2777 9	33
28	4190 4	4017 5	3848 7	3683 7	3522 7	3365 6	3212 4	3063 0	2917 3	2775 5	32
29	4187 5	4014 7	3845 9	3681 0	3520 1	3363 0	3209 9	3060 5	2915 0	2773 2	31
30	4184 6	4011 8	3843 1	3678 3	3517 4	3360 5	3207 3	3058 0	2912 6	2770 9	30
31	4181 7	4009 0	3840 3	3675 6	3514 8	3357 9	3204 8	3055 6	2910 2	2768 5	29
32	4178 7	4006 2	3837 6	3672 9	3512 1	3355 3	3202 3	3053 1	2907 8	2766 2	28
33	4175 8	4003 3	3834 8	3670 2	3509 5	3352 7	3199 8	3050 7	2905 4	2763 9	27
34	4172 9	4000 5	3832 0	3667 5	3506 9	3350 1	3197 3	3048 2	2903 0	2761 5	26
35	4170 0	3997 6	3829 2	3664 8	3504 2	3347 5	3194 7	3045 8	2900 6	2759 2	25
36	4167 1	3994 8	3826 5	3662 1	3501 6	3345 0	3192 2	3043 3	2898 2	2756 9	24
37	4164 2	3992 0	3823 7	3659 3	3498 9	3342 4	3189 7	3040 9	2895 8	2754 6	23
38	4161 3	3989 1	3820 9	3656 6	3496 3	3339 8	3187 2	3038 4	2893 4	2752 2	22
39	4158 4	3986 3	3818 1	3653 9	3493 6	3337 2	3184 7	3036 0	2891 1	2749 9	21
40	4155 5	3983 5	3815 4	3651 2	3491 0	3334 7	3182 2	3033 5	2888 7	2747 6	20
41	4152 6	3980 6	3812 6	3648 5	3488 4	3332 1	3179 7	3031 1	2886 3	2745 3	19
42	4149 7	3977 8	3809 8	3645 8	3485 7	3329 5	3177 2	3028 6	2883 9	2743 0	18
43	4146 8	3975 0	3807 1	3643 1	3483 1	3327 0	3174 7	3026 2	2881 5	2740 7	17
44	4143 9	3972 1	3804 3	3640 4	3480 5	3324 4	3172 2	3023 8	2879 2	2738 3	16
45	4141 0	3969 3	3801 5	3637 7	3477 8	3321 8	3169 7	3021 3	2876 8	2736 0	15
46	4138 1	3966 5	3798 8	3635 0	3475 2	3319 2	3167 1	3018 9	2874 4	2733 7	14
47	4135 2	3963 6	3796 0	3632 3	3472 6	3316 7	3164 6	3016 4	2872 0	2731 4	13
48	4132 3	3960 8	3793 3	3629 6	3469 9	3314 1	3162 1	3014 0	2869 7	2729 1	12
49	4129 4	3958 0	3790 5	3627 0	3467 3	3311 6	3159 6	3011 6	2867 3	2726 8	11
50	4126 6	3955 2	3787 7	3624 3	3464 7	3309 0	3157 1	3009 1	2864 9	2724 5	10
51	4123 7	3952 3	3785 0	3621 6	3462 1	3306 4	3154 6	3006 7	2862 5	2722 2	9
52	4120 8	3949 5	3782 2	3618 9	3459 4	3303 9	3152 1	3004 3	2860 2	2719 8	8
53	4117 9	3946 7	3779 5	3616 2	3456 8	3301 3	3149 7	3001 8	2857 8	2717 5	7
54	4115 0	3943 9	3776 7	3613 5	3454 2	3298 7	3147 2	2999 4	2855 4	2715 2	6
55	4112 1	3941 1	3774 0	3610 8	3451 6	3296 2	3144 7	2997 0	2853 1	2712 9	5
56	4109 2	3938 2	3771 2	3608 1	3448 9	3293 6	3142 2	2994 5	2850 7	2710 6	4
57	4106 3	3935 4	3768 5	3605 4	3446 3	3291 1	3139 7	2992 1	2848 3	2708 3	3
58	4103 5	3932 6	3765 7	3602 8	3443 7	3288 5	3137 2	2989 7	2846 0	2706 0	2
59	4100 6	3929 8	3763 0	3600 1	3441 1	3286 0	3134 7	2987 3	2843 6	2703 7	1
60	4097 7	3927 0	3760 2	3597 4	3438 5	3283 4	3132 2	2984 8	2841 2	2701 4	0
	229°	228°	227°	226°	225°	224°	223°	222°	221°	220°	
	Hour Angle										′

′	Hour Angle										
	140°	141°	142°	143°	144°	145°	146°	147°	148°	149°	
0	2701 4	2565 3	2433 0	2304 3	2179 4	2058 0	1940 4	1826 3	1715 8	1608 9	60
1	2699 1	2563 1	2430 8	2302 2	2177 3	2056 1	1938 4	1824 4	1714 0	1607 2	59
2	2696 8	2560 9	2428 6	2300 1	2175 3	2054 1	1936 5	1822 6	1712 2	1605 4	58
3	2694 5	2558 6	2426 5	2298 0	2173 2	2052 1	1934 6	1820 7	1710 4	1603 7	57
4	2692 2	2556 4	2424 3	2295 9	2171 2	2050 1	1932 7	1818 8	1708 6	1601 9	56
5	2689 9	2554 2	2422 1	2293 8	2169 1	2048 1	1930 7	1817 0	1706 8	1600 2	55
6	2687 6	2551 9	2420 0	2291 7	2167 1	2046 1	1928 8	1815 1	1705 0	1598 5	54
7	2685 4	2549 7	2417 8	2289 6	2165 0	2044 1	1926 9	1813 2	1703 2	1596 7	53
8	2683 1	2547 5	2415 6	2287 5	2163 0	2042 1	1925 0	1811 4	1701 4	1595 0	52
9	2680 8	2545 3	2413 5	2285 4	2160 9	2040 2	1923 0	1809 5	1699 6	1593 2	51
10	2678 5	2543 0	2411 3	2283 3	2158 9	2038 2	1921 1	1807 6	1697 8	1591 5	50
11	2676 2	2540 8	2409 1	2281 2	2156 9	2036 2	1919 2	1805 8	1696 0	1589 7	49
12	2673 9	2538 6	2407 0	2279 1	2154 8	2034 2	1917 3	1803 9	1694 2	1588 0	48
13	2671 6	2536 4	2404 8	2277 0	2152 8	2032 2	1915 3	1802 1	1692 4	1586 3	47
14	2669 3	2534 1	2402 6	2274 9	2150 7	2030 3	1913 4	1800 2	1690 6	1584 5	46
15	2667 1	2531 9	2400 5	2272 8	2148 7	2028 3	1911 5	1798 4	1688 8	1582 8	45
16	2664 8	2529 7	2398 3	2270 7	2146 7	2026 3	1909 6	1796 5	1687 0	1581 0	44
17	2662 5	2527 5	2396 2	2268 6	2144 6	2024 3	1907 7	1794 6	1685 2	1579 3	43
18	2660 2	2525 2	2394 0	2266 5	2142 6	2022 4	1905 8	1792 8	1683 4	1577 6	42
19	2657 9	2523 0	23919	2264 4	2140 6	2020 4	1903 9	1790 9	1681 6	1575 8	41
20	2655 6	2520 8	2389 7	2262 3	2138 5	2018 4	1901 9	1789 1	1679 8	1574 1	40
21	2653 4	2518 6	2387 5	2260 2	2136 5	2016 4	1900 0	1787 2	1678 0	1572 4	39
22	2651 1	2516 4	2385 4	2258 1	2134 5	2014 5	1898 1	1785 4	1676 2	1570 6	38
23	2648 8	2514 2	2383 2	2256 0	2132 4	2012 5	1896 2	1783 5	1674 4	1568 9	37
24	2646 5	2512 0	2381 1	2253 9	2130 4	2010 5	1894 3	1781 7	1672 7	1567 2	36
25	2644 3	2509 8	2378 9	2251 8	2128 4	2008 6	1892 4	1779 8	1670 9	1565 5	35
26	2642 0	2507 5	2376 8	2249 7	2126 3	2006 6	1890 5	1778 0	1669 1	1563 7	34
27	2639 7	2505 3	2374 6	2247 6	2124 3	2004 6	1888 6	1776 1	1667 3	1562 0	33
28	2637 5	2503 1	2372 5	2245 6	2122 3	2002 7	1886 7	1774 3	1665 5	1560 3	32
29	2635 2	2500 9	2370 4	2243 5	2120 3	2000 7	1884 8	1772 5	1663 7	1558 6	31
30	2632 9	2498 7	2368 2	2241 4	2118 3	1998 8	1882 9	1770 6	1661 9	1556 8	30
31	2630 7	2496 5	2366 1	2239 3	2116 2	1996 8	1881 0	1768 8	1660 2	1555 1	29
32	2628 4	2494 3	2363 9	2237 2	2114 2	1994 8	1879 1	1766 9	1658 4	1553 4	28
33	2626 1	2492 1	2361 8	2235 2	2112 2	1992 9	1877 2	1765 1	1656 6	1551 7	27
34	2623 9	2489 9	2359 6	2233 1	2110 2	1990 9	1875 3	1763 3	1654 8	1550 0	26
35	2621 6	2487 7	2357 5	2231 0	2108 2	1989 0	1873 4	1761 4	1653 1	1548 2	25
36	2619 3	2485 5	2355 4	2228 9	2106 1	1987 0	1871 5	1759 6	1651 3	1546 5	24
37	2617 1	2483 3	2353 2	2226 8	2104 1	1985 1	1869 6	1757 8	1649 5	1544 8	23
38	2614 8	2481 1	2351 1	2224 8	2102 1	1983 1	1867 7	1755 9	1647 7	1543 1	22
39	2612 6	2478 9	2349 0	2222 7	2100 1	1981 1	1865 8	1754 1	1646 0	1541 4	21
40	2610 3	2476 7	2346 8	2220 6	2098 1	1979 2	1863 9	1752 3	1644 2	1539 7	20
41	2608 0	2474 5	2344 7	2218 5	2096 1	1977 2	1862 0	1750 4	1642 4	1538 0	19
42	2605 8	2472 3	2342 6	2216 5	2094 1	1975 3	1860 1	1748 6	1640 6	1536 2	18
43	2603 5	2470 1	2340 4	2214 4	2092 1	1973 3	1858 3	1746 8	1638 9	1534 5	17
44	2601 3	2467 9	2338 3	2212 3	2090 0	1971 4	1856 4	1744 9	1637 1	1532 8	16
45	2599 0	2465 7	2336 2	2210 3	2088 0	1969 4	1854 5	1743 1	1635 3	1531 1	15
46	2596 8	2463 5	2334 0	2208 2	2086 0	1967 5	1852 6	1741 3	1633 6	1529 4	14
47	2594 5	2461 4	2331 9	2206 1	2084 0	1965 6	1850 7	1739 5	1631 8	1527 7	13
48	2592 3	2459 2	2329 8	2204 1	2082 0	1963 6	1848 8	1737 6	1630 0	1526 0	12
49	2590 0	2457 0	2327 7	2202 0	2080 0	1961 7	1846 9	1735 8	1628 3	1524 3	11
50	2587 8	2454 8	2325 5	2199 9	2078 0	1959 7	1845 1	1734 0	1626 5	1522 6	10
51	2585 5	2452 6	2323 4	2197 9	2076 0	1957 8	1843 2	1732 2	1624 8	1520 9	9
52	2583 3	2450 4	2321 3	2195 8	2074 0	1955 8	1841 3	1730 4	1623 0	1519 2	8
53	2581 0	2448 2	2319 2	2193 8	2072 0	1953 9	1839 4	1728 5	1621 2	1517 5	7
54	2578 8	2446 1	2317 0	2191 7	2070 0	1952 0	1837 5	1726 7	1619 5	1515 8	6
55	2576 5	2443 9	2314 9	2189 6	2068 0	1950 0	1835 7	1724 9	1617 7	1514 1	5
56	2574 3	2441 7	2312 8	2187 6	2066 0	1948 1	1833 8	1723 1	1616 0	1512 4	4
57	2572 1	2439 5	2310 7	2185 5	2064 0	1946 2	1831 9	1721 3	1614 2	1510 7	3
58	2569 8	2437 3	2308 6	2183 5	2062 0	1944 2	1830 0	1719 5	1612 5	1509 0	2
59	2567 6	2435 2	2306 5	2181 4	2060 0	1942 3	1828 2	1717 6	1610 7	1507 3	1
60	2565 3	2433 0	2304 3	2179 4	2058 0	1940 4	1826 3	1715 8	1608 9	1505 6	0
	219°	218°	217°	216°	215°	214°	213°	212°	211°	210°	′
	Hour Angle										

	150°	151°	152°	153°	154°	155°	156°	157°	158°	159°	
0	1505 6	1405 8	1309 6	1216 8	1127 6	1041 8	959 6	880 7	805 3	733 4	60
1	1503 9	1404 2	1308 0	1215 3	1126 1	1040 4	958 2	879 4	804 1	732 2	59
2	1502 2	1402 6	1306 4	1213 8	1124 7	1039 0	956 9	878 2	802 9	731 0	58
3	1500 5	1400 9	1304 9	1212 3	1123 2	1037 7	955 5	876 9	801 7	729 9	57
4	1498 9	1399 3	1303 3	1210 8	1121 8	1036 3	954 2	875 6	800 4	728 7	56
5	1497 2	1397 7	1301 7	1209 3	1120 3	1034 9	952 9	874 3	799 2	727 6	55
6	1495 5	1396 1	1300 2	1207 8	1118 9	1033 5	951 5	873 0	798 0	726 5	54
7	1493 8	1394 4	1298 6	1206 3	1117 4	1032 1	950 2	871 8	796 8	725 2	53
8	1492 1	1392 8	1297 0	1204 7	1116 0	1030 7	948 9	870 5	795 6	724 1	52
9	1490 4	1391 2	1295 5	1203 2	1114 5	1029 3	947 5	869 2	794 3	722 9	51
10	1488 7	1389 6	1293 9	1201 7	1113 1	1027 9	946 2	867 9	793 1	721 7	50
11	1487 1	1387 9	1292 3	1200 2	1111 6	1026 5	944 9	866 7	791 9	720 6	49
12	1485 4	1386 3	1290 8	1198 7	1110 2	1025 1	943 5	865 4	790 7	719 4	48
13	1483 7	1384 7	1289 2	1197 2	1108 7	1023 7	942 2	864 1	789 5	718 2	47
14	1482 0	1383 1	1287 6	1195 7	1107 3	1022 3	940 9	862 8	788 2	717 1	46
15	1480 3	1381 4	1286 1	1194 2	1105 8	1021 0	939 5	861 6	787 0	715 9	45
16	1478 7	1379 8	1284 5	1192 7	1104 4	1019 6	938 2	860 3	785 8	714 8	44
17	1477 0	1378 2	1283 0	1191 2	1103 0	1018 2	936 9	859 0	784 6	713 6	43
18	1475 3	1376 6	1281 4	1189 7	1101 5	1016 8	935 5	857 8	783 4	712 5	42
19	1473 6	1375 0	1279 8	1188 2	1100 1	1015 4	934 2	856 5	782 2	711 3	41
20	1472 0	1373 4	1278 3	1186 7	1098 6	1014 0	932 9	855 2	781 0	710 2	40
21	1470 3	1371 8	1276 7	1185 2	1097 2	1012 7	931 6	854 0	779 8	709 0	39
22	1468 6	1370 1	1275 2	1183 7	1095 8	1011 3	930 3	852 7	778 6	707 9	38
23	1467 0	1368 5	1273 6	1182 2	1094 3	1009 9	928 9	851 4	777 4	706 7	37
24	1465 3	1366 9	1272 1	1180 7	1092 9	1008 5	927 6	850 2	776 1	705 6	36
25	1463 6	1365 3	1270 5	1179 2	1091 5	1007 1	926 3	848 9	774 9	704 4	35
26	1461 9	1363 7	1269 0	1177 7	1090 0	1005 8	925 0	847 6	773 7	703 3	34
27	1460 3	1362 1	1267 4	1176 3	1088 6	1004 4	923 7	846 4	772 5	702 1	33
28	1458 6	1360 5	1265 9	1174 8	1087 2	1003 0	922 3	845 1	771 3	701 0	32
29	1457 0	1358 9	1264 3	1173 3	1085 7	1001 6	921 0	843 9	770 1	699 8	31
30	1455 3	1357 3	1262 8	1171 8	1084 3	1000 3	919 7	842 6	768 9	698 7	30
31	1453 6	1355 7	1261 2	1170 3	1082 9	998 9	918 4	841 4	767 7	697 6	29
32	1452 0	1354 1	1259 7	1168 8	1081 4	997 5	917 1	840 1	766 5	696 4	28
33	1450 3	1352 5	1258 1	1167 3	1080 0	996 2	915 8	838 8	765 3	695 3	27
34	1448 6	1350 9	1256 6	1165 8	1078 6	994 8	914 5	837 6	764 1	694 1	26
35	1447 0	1349 3	1255 1	1164 4	1077 2	993 4	913 2	836 3	763 0	693 0	25
36	1445 3	1347 7	1253 5	1162 9	1075 7	992 1	911 8	835 1	761 8	691 9	24
37	1443 7	1346 1	1252 0	1161 4	1074 3	990 7	910 5	833 8	760 6	690 7	23
38	1442 0	1344 5	1250 4	1159 9	1072 9	989 3	909 2	832 6	759 4	689 6	22
39	1440 4	1342 9	1248 9	1158 4	1071 5	988 0	907 9	831 3	758 2	688 5	21
40	1438 7	1341 3	1247 4	1157 0	1070 0	986 6	906 6	830 1	757 0	687 3	20
41	1437 1	1339 7	1245 8	1155 5	1068 6	985 2	905 3	828 8	755 8	686 2	19
42	1435 4	1338 1	1244 3	1154 0	1067 2	983 9	904 0	827 6	754 6	685 1	18
43	1433 8	1336 5	1242 8	1152 5	1065 8	982 5	902 7	826 4	753 4	683 9	17
44	1432 1	1334 9	1241 2	1151 1	1064 4	981 2	901 4	825 1	752 2	682 8	16
45	1430 5	1333 3	1239 7	1149 6	1063 0	979 8	900 1	823 9	751 1	681 7	15
46	1428 8	1331 7	1238 2	1148 1	1061 5	978 5	898 8	822 6	749 9	680 5	14
47	1427 2	1330 1	1236 6	1146 6	1060 1	977 1	897 5	821 4	748 7	679 4	13
48	1425 5	1328 6	1235 1	1145 2	1058 7	975 7	896 2	820 1	747 5	678 3	12
49	1423 9	1327 0	1233 6	1143 7	1057 3	974 4	894 9	818 9	746 3	677 2	11
50	1422 2	1325 4	1232 1	1142 2	1055 9	973 0	893 6	817 7	745 1	676 0	10
51	1420 6	1323 8	1230 5	1140 8	1054 5	971 7	892 3	816 4	744 0	674 9	9
52	1418 9	1322 2	1229 0	1139 3	1053 1	970 3	891 0	815 2	742 8	673 8	8
53	1417 3	1320 6	1227 5	1137 8	1051 7	969 0	889 7	814 0	741 6	672 7	7
54	1415 7	1319 1	1226 0	1136 4	1050 3	967 6	888 5	812 7	740 4	671 6	6
55	1414 0	1317 5	1224 4	1134 9	1048 9	966 3	887 2	811 5	739 3	670 4	5
56	1412 4	1315 9	1222 9	1133 4	1047 5	964 9	885 9	810 3	738 1	669 3	4
57	1410 7	1314 3	1221 4	1132 0	1046 1	963 6	884 6	809 0	736 9	668 2	3
58	1409 1	1312 7	1219 9	1130 5	1044 7	962 2	883 3	807 8	735 7	667 1	2
59	1407 5	1311 2	1218 4	1129 1	1043 2	960 9	882 0	806 6	734 6	666 0	1
60	1405 8	1309 6	1216 8	1127 6	1041 8	959 6	880 7	805 3	733 4	664 9	0
	209°	208°	207°	206°	205°	204°	203°	202°	201°	200°	′

Hour Angle

′	Hour Angle										
	160°	161°	162°	163°	164°	165°	166°	167°	168°	169°	
0	664 9	599 7	538 0	479 7	424 7	373 1	324 9	280 1	238 6	200 4	60
1	663 7	598 7	537 0	478 7	423 8	372 3	324 2	279 4	237 9	199 8	59
2	662 6	597 6	536 0	477 8	422 9	371 5	323 4	278 6	237 2	199 2	58
3	661 5	596 6	535 0	476 9	422 1	370 7	322 6	277 9	236 6	198 6	57
4	660 4	595 5	534 0	475 9	421 2	369 8	321 8	277 2	235 9	198 0	56
5	659 3	594 5	533 0	475 0	420 3	369 0	321 1	276 5	235 3	197 4	55
6	658 2	593 4	532 0	474 0	419 4	368 2	320 3	275 8	234 6	196 8	54
7	657 1	592 4	531 0	473 1	418 5	367 4	319 5	275 1	233 9	196 2	53
8	656 0	591 3	530 0	472 2	417 7	366 5	318 8	274 3	233 3	195 6	52
9	654 9	590 3	529 0	471 2	416 8	365 7	318 0	273 6	232 6	195 0	51
10	653 8	589 2	528 0	470 3	415 9	364 9	317 2	272 9	232 0	194 4	50
11	652 7	588 2	527 1	469 4	415 0	364 1	316 5	272 2	231 3	193 8	49
12	651 6	587 1	526 1	468 4	414 1	363 2	315 7	271 5	230 7	193 2	48
13	650 5	586 1	525 1	467 5	413 3	362 4	314 9	270 8	230 0	192 6	47
14	649 4	585 0	524 1	466 6	412 4	361 6	314 2	270 1	229 4	192 0	46
15	648 3	584 0	523 1	465 6	411 5	360 8	313 4	269 4	228 7	191 4	45
16	647 2	582 9	522 1	464 7	410 6	360 0	312 6	268 7	228 1	190 8	44
17	646 1	581 9	521 1	463 8	409 8	359 1	311 9	268 0	227 4	190 2	43
18	645 0	580 9	520 2	462 8	408 9	358 3	311 1	267 3	226 8	189 6	42
19	643 9	579 8	519 2	461 9	408 0	357 5	310 4	266 6	226 1	189 0	41
20	642 8	578 8	518 2	461 0	407 2	356 7	309 6	265 9	225 5	188 4	40
21	641 7	577 7	517 2	460 1	406 3	355 9	308 9	265 2	224 8	187 8	39
22	640 6	576 7	516 2	459 1	405 4	355 1	308 1	264 5	224 2	187 2	38
23	639 5	575 7	515 3	458 2	404 6	354 3	307 3	263 8	223 5	186 7	37
24	638 4	574 6	514 3	457 3	403 7	353 5	306 6	263 1	222 9	186 1	36
25	637 3	573 6	513 3	456 4	402 8	352 7	305 8	262 4	222 3	185 5	35
26	636 2	572 6	512 3	455 4	402 0	351 8	305 1	261 7	221 6	184 9	34
27	635 1	571 5	511 3	454 5	401 1	351 0	304 3	261 0	221 0	184 3	33
28	634 0	570 5	510 4	453 6	400 2	350 2	303 6	260 3	220 3	183 7	32
29	633 0	569 5	509 4	452 7	399 4	349 4	302 8	259 6	219 7	183 2	31
30	631 9	568 4	508 4	451 8	398 5	348 6	302 1	258 9	219 1	182 6	30
31	630 8	567 4	507 5	450 9	397 7	347 8	301 3	258 2	218 4	182 0	29
32	629 7	566 4	506 5	449 9	396 8	347 0	300 6	257 5	217 8	181 4	28
33	628 6	565 4	505 5	449 0	395 9	346 2	299 8	256 8	217 2	180 8	27
34	627 5	564 3	504 5	448 1	395 1	345 4	299 1	256 1	216 5	180 3	26
35	626 5	563 3	503 6	447 2	394 2	344 6	298 4	255 5	215 9	179 7	25
36	625 4	562 3	502 6	446 3	393 4	343 8	297 6	254 8	215 3	179 1	24
37	624 3	561 3	501 6	445 4	392 5	343 0	296 9	254 1	214 6	178 5	23
38	623 2	560 2	500 7	444 5	391 7	342 2	296 1	253 4	214 0	178 0	22
39	622 1	559 2	499 7	443 6	390 8	341 4	295 4	252 7	213 4	177 4	21
40	621 1	558 2	498 7	442 7	390 0	340 6	294 7	252 0	212 8	176 8	20
41	620 0	557 2	497 8	441 8	389 1	339 8	293 9	251 3	212 1	176 2	19
42	618 9	556 2	496 8	440 9	388 3	339 0	293 2	250 7	211 5	175 7	18
43	617 8	555 2	495 9	440 0	387 4	338 3	292 4	250 0	210 9	175 1	17
44	616 8	554 1	494 9	439 0	386 6	337 5	291 7	249 3	210 3	174 5	16
45	615 7	553 1	493 9	438 1	385 7	336 7	291 0	248 6	209 6	174 0	15
46	614 6	552 1	493 0	437 2	384 9	335 9	290 2	248 0	209 0	173 4	14
47	613 6	551 1	492 0	436 3	384 0	335 1	289 5	247 3	208 4	172 8	13
48	612 5	550 1	491 1	435 4	383 2	334 3	288 8	246 6	207 8	172 3	12
49	611 4	549 1	490 1	434 5	382 3	333 5	288 0	245 9	207 1	171 7	11
50	610 3	548 1	489 2	433 6	381 5	332 7	287 3	245 3	206 5	171 1	10
51	609 3	547 0	488 2	432 8	380 7	332 0	286 6	244 6	205 9	170 6	9
52	608 2	546 0	487 3	431 9	379 8	331 2	285 9	243 9	205 3	170 0	8
53	607 2	545 0	486 3	431 0	379 0	330 4	285 1	243 2	204 7	169 5	7
54	606 1	544 0	485 4	430 1	378 1	329 6	284 4	242 6	204 1	168 9	6
55	605 0	543 0	484 4	429 2	377 3	328 8	283 7	241 9	203 5	168 4	5
56	604 0	542 0	483 5	428 3	376 5	328 0	283 0	241 2	202 8	167 8	4
57	602 9	541 0	482 5	427 4	375 6	327 3	282 2	240 6	202 2	167 2	3
58	601 8	540 0	481 6	426 5	374 8	326 5	281 5	239 9	201 6	166 7	2
59	600 8	539 0	480 6	425 6	374 0	325 7	280 8	239 2	201 0	166 0	1
60	599 7	538 0	479 7	424 7	373 1	324 9	280 1	238 6	200 4	165 6	0
	199°	198°	197°	196°	195°	194°	193°	192°	191°	190°	
	Hour Angle										′

170°	171°	172°	173°	174°	175°	176°	177°	178°	179°	
165 6	134 1	105 9	81 1	59 6	41 4	26 5	14 9	6 6	1 7	60
165 0	133 6	105 5	80 7	59 2	41 1	26 2	14 7	6 5	1 6	59
164 5	133 1	105 0	80 3	58 9	40 8	26 0	14 6	6 4	1 5	58
163 9	132 6	104 6	79 9	58 6	40 5	25 8	14 4	6 3	1 5	57
163 4	132 1	104 2	79 5	58 2	40 3	25 6	14 2	6 2	1 4	56
162 8	131 6	103 7	79 2	57 9	40 0	25 4	14 1	6 1	1 4	55
162 3	131 1	103 3	78 8	57 6	39 7	25 2	13 9	6 0	1 3	54
161 7	130 6	102 9	78 4	57 3	39 4	24 9	13 7	5 9	1 3	53
161 2	130 1	102 4	78 0	56 9	39 2	24 7	13 6	5 8	1 2	52
160 6	129 6	102 0	77 6	56 6	38 9	24 5	13 4	5 7	1 2	51
160 1	129 2	101 6	77 3	56 3	38 6	24 3	13 3	5 6	1 1	50
159 6	128 7	101 1	76 9	56 0	38 4	24 1	13 1	5 5	1 1	49
159 0	128 2	100 7	76 5	55 7	38 1	23 9	13 0	5 4	1 1	48
158 5	127 7	100 3	76 1	55 3	37 8	23 7	12 8	5 3	1 0	47
157 9	127 2	99 8	75 8	55 0	37 6	23 5	12 7	5 2	1 0	46
157 4	126 7	99 4	75 4	54 7	37 3	23 3	12 5	5 1	0 9	45
156 9	126 2	99 0	75 0	54 4	37 1	23 1	12 4	5 0	0 9	44
156 3	125 8	98 5	74 6	54 1	36 8	22 8	12 2	4 9	0 9	43
155 8	125 3	98 1	74 3	53 7	36 5	22 6	12 1	4 8	0 8	42
155 2	124 8	97 7	73 9	53 4	36 3	22 4	11 9	4 7	0 8	41
154 7	124 3	97 3	73 5	53 1	36 0	22 2	11 8	4 6	0 7	40
154 2	123 8	96 8	73 2	52 8	35 8	22 0	11 6	4 5	0 7	39
153 6	123 4	96 4	72 8	52 5	35 5	21 8	11 5	4 4	0 7	38
153 1	122 9	96 0	72 4	52 2	35 3	21 6	11 3	4 3	0 6	37
152 6	122 4	95 6	72 1	51 9	35 0	21 4	11 2	4 2	0 6	36
152 1	121 9	95 2	71 7	51 6	34 7	21 2	11 0	4 1	0 6	35
151 5	121 5	94 7	71 3	51 3	34 5	21 0	10 9	4 1	0 5	34
151 0	121 0	94 3	71 0	51 0	34 2	20 8	10 8	4 0	0 5	33
150 5	120 5	93 9	70 6	50 7	34 0	20 6	10 6	3 9	0 5	32
149 9	120 1	93 5	70 3	50 3	33 7	20 5	10 5	3 8	0 4	31
149 4	119 6	93 1	69 9	50 0	33 5	20 3	10 3	3 7	0 4	30
148 9	119 1	92 7	69 5	49 7	33 2	20 1	10 2	3 6	0 4	29
148 4	118 7	92 3	69 2	49 4	33 0	19 9	10 1	3 6	0 4	28
147 8	118 2	91 8	68 8	49 1	32 8	19 7	9 9	3 5	0 3	27
147 3	117 7	91 4	68 5	48 8	32 5	19 5	9 8	3 4	0 3	26
146 8	117 3	91 0	68 1	48 5	32 3	19 3	9 7	3 3	0 3	25
146 3	116 8	90 6	67 8	48 2	32 0	19 1	9 5	3 2	0 3	24
145 8	116 3	90 2	67 4	47 9	31 8	18 9	9 4	3 2	0 2	23
145 2	115 9	89 8	67 1	47 6	31 5	18 7	9 3	3 1	0 2	22
144 7	115 4	89 4	66 7	47 3	31 3	18 6	9 1	3 0	0 2	21
144 2	114 9	89 0	66 4	47 1	31 1	18 4	9 0	2 9	0 2	20
143 7	114 5	88 6	66 0	46 8	30 8	18 2	8 9	2 9	0 2	19
143 2	114 0	88 2	65 7	46 5	30 6	18 0	8 7	2 8	0 1	18
142 7	113 6	87 8	65 3	46 2	30 4	17 8	8 6	2 7	0 1	17
142 2	113 1	87 4	65 0	45 9	30 1	17 6	8 5	2 7	0 1	16
141 6	112 7	87 0	64 6	45 6	29 9	17 5	8 4	2 6	0 1	15
141 1	112 2	86 6	64 3	45 3	29 6	17 3	8 2	2 5	0 1	14
140 6	111 7	86 2	63 9	45 0	29 4	17 1	8 1	2 4	0 1	13
140 1	111 3	85 8	63 6	44 7	29 2	16 9	8 0	2 4	0 1	12
139 6	110 8	85 4	63 3	44 4	28 9	16 8	7 9	2 3	0 1	11
139 1	110 4	85 0	62 9	44 2	28 7	16 6	7 8	2 3	0 0	10
138 6	109 9	84 6	62 6	43 9	28 5	16 4	7 6	2 2	0 0	9
138 1	109 5	84 2	62 2	43 6	28 3	16 2	7 5	2 1	0 0	8
137 6	109 0	83 8	61 9	43 3	28 0	16 1	7 4	2 1	0 0	7
137 1	108 6	83 4	61 6	43 0	27 8	15 9	7 3	2 0	0 0	6
136 6	108 1	83 0	61 2	42 7	27 6	15 7	7 2	1 9	0 0	5
136 1	107 7	82 6	60 9	42 5	27 4	15 6	7 1	1 9	0 0	4
135 6	107 3	82 2	60 6	42 2	27 1	15 4	6 9	1 8	0 0	3
135 1	106 8	81 9	60 2	41 9	26 9	15 2	6 8	1 8	0 0	2
134 6	106 4	81 5	59 9	41 6	26 7	15 1	6 7	1 7	0 0	1
134 1	105 9	81 1	59 6	41 4	26 5	14 9	6 6	1 7	0 0	0
189°	188°	187°	186°	185°	184°	183°	182°	181°	180°	′

Hour Angle

A FEW VALUABLE OPINIONS.

RIVISTA MARITTIMA ITALIANA, *February* 1910.

Bibliografia.

"Il procedimento del de Aquino è ingegnosissimo, poichè, spezzando in due triangoli sferici rettangoli il noto triangolo SPZ, conducendo l'arco normale all'arco PZ, dà una serie di relazioni ben note, che abilmente utilizzate, per mezzo di una tavola di altezza ad azimut e tavole ausiliarie (pagg. 3–128), rende il conttegio pratico cosi semplice ed esatto per le esigenze nautiche da destare in verità meraviglia."—E. Millosevich, *Director of the Observatory of Rome, Italy.*

Almirante GARCIA MANSILLA, Determinación del punto en la mar, Buenos Aires, 1910.

"Sea como fuera, debo mencionar en primer término y con especial satisfacción, las tablas de Altura y Azimut, del señor Radler de Aquino por ser, sin duda alguna, la mejor solución del problema que yo conozco."—*From Paper read before the Congreso Cientifico Internacional held at Buenos Aires*, 1910.

ANNALEN DER HYDROGRAPHIE UND MARITIMEN METEOROLOGIE, *November* 1910.

Radler de Aquino: Altitude and azimuth tables for facilitating the determination of lines of position and geographical position at sea. The simplest and readiest in solution. Spherical traverse tables for solving all problems of navigation. 8vo. 128 pp. London, 1910. J. D. Potter, and Rio de Janeiro, 1910. Radler de Aquino. Preis 10s. 6d.

Die Höhen- und Azimut-Tafeln des Leutnants Radler de Aquino der brasilianischen Kriegs-Marine liefern ein recht bequemes Hilfsmittel, um die für Anwendung der Marcq St. Hilaireschen Methode notwendigen Berechnungen der Höhe und des Azimuts ohne logarithmische Rechnung durchzuführen. Durch Zerlegung des Poldreiecks in zwei rechtwinklige sphärische Dreiecke (durch Fällen eines Lots vom Gestirnsort auf den Meridian) wird ermöglicht, dass die Lösung der Hauptaufgaben der nautischen Astronomie mit den Tafeln nach einheitlicher Methode zu erreichen ist. Um die Höhe und das Azimut eines Gestirns zu finden, geht man mit der Abweichung und dem Stundenwinkel in die Tafel und entnimmt zunächst Näherungswerte zweier Hilfsgrössen (a und b). Mit diesen findet man durch nochmaligen Eingang den der Abweichung entsprechenden Wert von b und aus diesem den Wert eines Stundenwinkels, der anstatt des aus der gegissten Länge hergeleiteten Stundenwinkels benutzt wird. Das gefundene b und die zweckentsprechend geändert Breite geben Höhe und Azimut, die also nicht für den gegissten Ort, sondern für einen Hilfspunkt gelten. Es ist jedoch nach den in den Tafeln gegebenen Anweisungen nur mit wenig Mehrarbeit verknüpft, wenn man Höhe und Azimut für das gegisste Besteck ermitteln will. Die Tafeln lassen sich, wie in der Gebrauchsanweisung ausführlich auseinander gesetzt wird, auch zur Lösung anderer Aufgaben der nautischen Astronomie mit Vorteil verwenden. So lässt sich mit den Tafeln leicht ermitteln, wenn Höhe und Azimut eines Gestirnes beobachtet sind, zu welchem Gestirne diese Grössen gehören. Auch die Ermittlung des Zeit- und des Zeithöhen-Azimuts, der Amplitude und der Höhe eines Gestirns im Ersten Vertikal usw. lässt an Bequemlichkeit nichts zu wünschen übrig, so dass sich diese Tafeln bald Freunde unter den Nautikern erwerben werden, die Höhenberechnungen ohne Benutzung der Logarithmentafeln bevorzugen. Sk.

NAUTICAL MAGAZINE, *February* 1910.

"Whether or no any marked simplification results from the use of the new processes is a point which the navigator may easily determine for himself, but we have no hesitation in endorsing the verdict of the Hydrographer of the U.S. Navy, that 'the plan of the work is sound in principle and scientific in conception.' The central idea is distinctly original, and the work forms an interesting addition to the literature of Nautical Astronomy."

"Altogether the book is a remarkable triumph of ingenuity, and does credit to designer and printer and publisher."—Rev. William Hall, R.N., *in the Nautical Magazine for November*, 1910, *page* 486.

PARECERES OFFICIAES.

Cópia.—Ministerio da Marinha. Estado Maior da Armada. Em 15 de setembro de 1910.—Ao Sr. Vice-almirante Ministro da Marinha. Passo ás vossas mãos com os presentes papeis o parecer apresentado pelo capitão-tenente Augusto Cesar Burlamaqui, membro da commissão nomeada pelo capitão de mar e guerra João Baptista das Neves, commandante do encouraçado *Minas Geraes*, para estudar o trabalho apresentado pelo capitão-tenente Radler de Aquino, intitulado *Altitude and Azimuth Tables*. Não só pela leitura do referido parecer, como pela opinião daquelle commandante, que diz que o uso dessas taboas tornou-se generalisado a bordo durante a longa commissão emprehendida pelo mesmo encouraçado, do porto de Newcastle-on-Tyne ao desta Capital, facto este que demonstra a sua utilidade e o modo facil e pratico do seu emprego, podereis verificar que o trabalho desse intelligente e operoso official é digno de ser adoptado, pois torna de extrema facilidade o traçado da recta de posição e resolve com um grau de precisão acceitavel para a navegação um numeroso grupo de problemas. Saude e fraternidade. (Assignado) H. PINHEIRO GUEDES, Vice-almirante, Chefe do Estado Maior da Armada.

Cópia.—Commando do encouraçado *Minas Geraes*. Rio de Janeiro, 9 de setembro de 1910. N. 264.—Sr. Contra-Almirante Commandante da Divisão de Encouraçados. Cumpre-me enviar-vos o parecer apresentado pelo Sr. capitão-tenente Augusto Cesar Burlamaqui sobre o trabalho intitulado *Altitude and Azimuth Tables*, do Sr. capitão tenente Radler de Aquino. Tendo apparecido este trabalho antes da partida deste encouraçado do porto de Newcastle, nomeei uma commissão de tres officiaes do navio para dar parecer sobre o seu valor e utilidade; esta commissão era composta dos Srs. capitães-tenentes Augusto Cesar Burlamaqui, Alfredo Dodsworth e Leopoldo Nobrega Moreira. Pela leitura do parecer, podereis verificar a opinião favoravel da commissão, cabendo pela minha parte accrescentar que o uso dessas taboas tornou-se generalisado a bordo durante a commissão, facto este que demonstra a sua utilidade e o modo facil e pratico do seu emprego. Estas taboas representam mais um importante trabalho dado á publicidade pelo seu illustre e operoso autor. Saude e fraternidade. JOÃO BAPTISTA DAS NEVES, capitão de mar e guerra.

Ilha Grande, 10 de abril de 1910.—Passo ás vossas mãos o parecer elaborado pela commissão por vós nomeada para emittir juizo sobre o trabalho da lavra do Sr. capitão-tenente Radler de Aquino, intitulado *Altitude and Azimuth Tables*. Em abono das referidas taboas do estudioso official da nossa marinha de guerra vem a longa commissão desempenhada pelo couraçado *Minas Geraes*, sob o vosso commando, durante a qual foram verificados á saciedade os magnificos resultados fornecidos pelas taboas em comparação com os varios processos utilizados a bordo para o mesmo fim. O methodo Marcq, hoje definitivamente adoptado, encontra no inestimavel livro do Sr. capitão-tenente Radler de Aquino a sua resolução simples, rapida e segura, tornando de extrema facilidade o traçado da recta de posição e resolvendo com um gráo de precisão acceitavel para a navegação um numeroso grupo de problemas. Julgo que as taboas de 360 paginas, que o Sr. capitão-tenente Radler de Aquino promette publicar, facilitarão de modo tal o calculo das coordenadas da posição do navio, que affirmo esperar o mais favoravel acolhimento por todos os que se interessam pelos progressos da navegação.—*Augusto Cesar Burlamaqui*, capitão-tenente, instructor de navegação. Ao Sr. capitão de mar e guerra commandante do couraçado *Minas Geraes*, João Baptista das Neves.

OTHER WORKS OF THE AUTHOR NOT MENTIONED IN THESE TABLES

O Methodo de Marcq Saint Hilaire para um observador determinar a sua posição no mar, com taboas para a sua applicação. *Imprensa Nacional*, Rio de Janeiro, 1902. This work was printed by order of the Minister of Marine, and was first published in the *Revista Maritima Brazileira* for November, 1899, January, 1900, and October, 1900.

Typos de calculo para o methodo de Marcq Saint Hilaire pela modificação do Dr. Otto Fulst de Hamburgo. *Imprensa Nacional*, Rio de Janeiro, 1902. Reprinted from the *Revista Maritima Brazileira* for December, 1901.

Estudo theorico e pratico dos Instrumentos Nauticos de Lord Kelvin. Descripção e theoria da agulha de Lord Kelvin. Magnetismo dos navios. Theoria geral dos desvios das agulhas e de sua compensação. *Imprensa Nacional*, Rio de Janeiro, 1902. Reprinted by order of the Minister of Marine from the *Revista Maritima Brazileira*, August–September, 1900, January, 1901, and April–May, 1901.

Causas da instabilidade do caracter magnetico de um navio. Prisma azimuthal de Lord Kelvin. Regulação das agulhas por meio de azimuths. Determinação do caracter magnetico de um navio. Compensação horizontal das agulhas com azmuths. Balança magnetica de Lord Kelvin. Compensação vertical do desvio de banda. Machina de sondar de Lord Kelvin. Indicadores : mecanico e chimico. Theoria e manejo pratico. *Imprensa Nacional*, Rio de Janeiro, 1903. Reprinted from the *Revista Maritima Brazileira*, May and July, 1903, pages 1291 and 8, and March, 1902, page 1202.

Compensação e regulação das agulhas sem azimuths. Deflector de Lord Kelvin. Theoria e manejo pratico. Methodo do Kaptain Clausen. *Imprensa Nacional*, Rio de Janeiro, 1903. Reprinted from the *Revista Maritima Brazileira*, June, 1903. This work has been recently translated into English by Commander L. H. Chandler, U.S. Navy and published in the *United States Naval Institute Proceedings* for December, 1909.

Estudo theorico e pratico dos Instrumentos Nauticos de Lord Kelvin. Magnetismo dos navios. Compensação e regulação das agulhas com e sem azimuths. Sondagens no mar. New edition of above three works, by order of the Minister of Marine. *Imprensa Nacional*, Rio de Janeiro, 1910.

A Signaria Naval. Reprinted from the *Revista Maritima Brazileira*, January, 1903.

Estudo elementar de Trigonometria Espherica e algumas das suas applicações á Astronomia Espherica, Navegação e Geographia, edited by H. Garnier, Paris and Rio de Janeiro, 1903. Price 4s.

Relatorio annual da Associação Protectora dos Homens do Mar de 1903–1904. Rio de Janeiro, 1904.

Jiu-Jitsu. Educação Physica Japoneza, pelo Mr. H. Irving Hancock. Joint translation from English with the late Capitão de corveta J. A. dos Santos Porto. Rio de Janeiro, 1905. Price 4s.

Nomograms for Deducing Altitude and Azimuth and for Star Identification and Finding Course and Distance in Great Circle Sailing. Reprinted from the *United States Naval Institute Proceedings* for June, 1908.

Nomogrammas para achar alturas e azimuths, &c. Reprinted from the *Revista Maritima Brazileira*, July, 1908.

Taboas para achar alturas e azimuths facilitando a determinação de rectas de posição e o ponto observado no mar. *Imprensa Nacional*, 1910. Reprinted from the *Revista Maritima Brazileira*, August, 1910.

A Nomogram for Compass Deviations, with an Elementary Exposition of the Two Parallel Scale Nomograms. By Professor Guiseppe Pesci, Italian Navy. Translated from the original manuscript in Italian by Lieutenant Radler de Aquino. Reprinted from the *United States Naval Institute Proceedings* for December, 1910.

And many other articles in the *Revista Maritima Brazileira* since 1899.

LIST OF NAUTICAL WORKS

PUBLISHED BY

J. D. POTTER.

145, MINORIES,
LONDON, E.C.

LIST OF NAUTICAL WORKS

PUBLISHED BY J. D. POTTER.

ALTITUDE TABLES.

s. d.

Computed for Intervals of Four Minutes between the Parallels of Latitude 31° and 60° and Parallels of Declination 0° and 24°, designed for the Determination of the Position Line at all Hour Angles without Logarithmic Computation, by *Frederick Ball, M.A. (late Scholar of Exeter College, Oxford), Chaplain and Naval Instructor in His Majesty's Fleet* 15 0

Ditto, ditto, between the Parallels of Latitude 0° and 30° and Parallels of Declination 0° and 24° 15 0

Ditto, ditto, between the Parallels of Latitude 24° and 60° and Parallels of Declination 24° and 60° 15 0

These Tables are so arranged for working by the New Navigation that only one correction has to be applied to the altitude taken direct from the book. The entire logarithmic work is replaced by a single subtraction and the application of the correction. In conjunction with the Nautical Almanac all the usual problems of Navigation are solved.

The Tables have been adopted for use in the Japanese Navy.

Altitude and Azimuth Tables, for Facilitating the Determination of Lines of Position and Geographical Position at Sea. The simplest and readiest in solution. Plane and Spherical Traverse Tables for solving all problems of navigation. By *Lieut. Radler de Aquino* (Brazilian Navy). All sights for position are worked out by the same method *without logarithms*, with hardly any calculation. All the other problems in navigation are easily and rapidly solved by inspection without interpolation. This work has received the favourable endorsement of the United States Hydrographic Office. 2nd Stereotyped Edition 10 6

New Log and Versine Altitude Tables (Reprinted from the 2nd Edition of above Book), by *Lieut. Radler de Aquino* (Brazilian Navy). The simplest and readiest way of finding the Altitude by means of *logarithms* 2 6

COLUMBUS.

The Landfall of Columbus on his First Voyage to America, with a Translation of The Baron Bonnefoux's History of his previous life. also a Chart showing his Track from the Landfall to Cuba, and an outline of his subsequent voyages, by *Capt. A. B. Becher, R.N.* (1856) 12 0

COOKERY.

Ship's Cook and Steward's Guide, containing Hints for Management, and Two Hundred and Fifty Recipes, by *James B. Wilson* 1 0

List of Nautical Works published by J. D. POTTER.

AZIMUTHS.

s. d

Davis's Sun's True Bearing, or Azimuth Tables (30° N. to 30° S.), by *J. E. and Percy L. H. Davis.* The only means of ensuring a correct course at sea is by the use of calculated or tabular azimuths, and the latter render the operation speedy and accurate. These tables, an addendum to those of Capt. Burdwood, R.N., which preceded them, have been in very general use since their publication. The instructions in several European languages have proved of great service to foreign seamen 11 6

(Supplied to H.M. Fleet by Admiralty order.)

Davis's Supplementary Azimuth Tables (now published separately). The Time Azimuth Tables in general use do not often give azimuths near the meridian, which are in frequent demand for ex-meridian observations, but they will be found in this book, in addition to complete tables extending to latitude 64° 8 0

(Supplied to H.M. Fleet by Admiralty order.)

Davis's Star Azimuth Tables, computed for all latitudes between **60° North** and **60° South,** by *P. L. H. Davis.* This book has followed on the very general adoption of stellar observations as a means of navigation, and supplies the seaman with the same details regarding stars, as he can get from "Burdwood and Davis" when the sun is concerned. Some ingenious altitude marks are used for the first time in these tables which materially aid in the identification of any hastily observed star, as to which doubt may exist 11 6

(Supplied to H.M. Fleet by Admiralty order.)

High Latitude Tables, between 61° and 78°. By *Percy L. H. Davis* 7 0

This work, which was originally prepared for and used by the Antarctic Expedition of 1901, has now been adopted for use in H.M. Navy and will certainly be a necessity in all ships trading to northern ports.

(Supplied to H.M. Fleet by Admiralty order.)

Alt-Azimuth Tables. Under this title J. D. Potter will shortly publish a series of four books, two of which deal with latitudes and Declinations contained in Burdwood and Davis, and two with the higher Declinations needed for star work. The distinctive feature of these tables, which are being prepared by Mr. Percy L. H. Davis, F.R.A.S., and incorporate various suggestions made by the Hydrographer of the Navy, is that they will enable the user to correlate at a glance the Altitude and Azimuth of any observed body with its Hour Angle and Declination and thus immediately to recognise any star of whose identity he may be uncertain. A leaflet published for purposes of copyright is on sale, *price* 6*d.*

The altitudes are printed in heavy figures, and the azimuths in ordinary type, each being for the time opposite which it appears. There is no altitude limit in these tables, the quantities being given from the meridian to the horizon

Short, Accurate, and Comprehensive Altitude-Azimuth Tables to show the true bearing of the Sun, Moon, Planets, &c., for latitude 0° to 75° north or south; altitudes 0° to 75°; and declination 30° north to 30° south; also the Approximate Ship Time, by *A. C. Johnson, R.N.* (Published by request) 3 6

(Supplied to H.M. Fleet by Admiralty order.)

Captain Weir's Azimuth Diagram 1 6

(Supplied to H.M. Fleet by Admiralty order.)

Time Azimuth Diagram, by *Hugh Godfray, M.A.* 3 0

DOUBLE ALTITUDES.

A Method for finding the Latitude by the Simultaneous Altitudes of Two Stars, by *Capt. Burdwood, R.N.* (reprinted 1896) 1 0

List of Nautical Works published by J. D. POTTER.

CHARTS.

s. d.

Charts: their use and meaning, with thirteen figures and eight charts, by *Dr. G. Herbert Fowler* 4 0

This, which is believed to be the first book on charts yet published, brings together information which hitherto has been obtainable only from verbal teaching. It deals with Mercator and Gnomonic navigational charts, and with Meteorological and other scientific charts, from a practical point of view in simple language.

CHRONOMETERS.

Davis's "Chronometer" Tables; or, hour angles for selected altitudes between latitudes 0° and 50°, with variations for 1′ in all elements, by *P. L. H. Davis.* Means of working a Sun "Chronometer" arithmetically have been for many years a desideratum, and have been published, in 1793, by Lalande; in 1827, by Lynn; and by Hommey, in 1863; but Mr. Davis, by the omission of useless or undesirable altitudes, and the inclusion of Variations in 1′ of Altitude, Latitude, and Declination, has made a table of great practical utility. The book, as a substitute for or a check on logarithmic calculation, is almost a necessity, and is especially useful in latitudes less than 45°. A comparison has been made in actual work of the tabular results with those obtained in the ordinary way, showing practically identical results 11 6

Notes on the Management of Chronometers and the Measurement of Meridian Distances, by *Rear-Admiral Charles Shadwell, F.R.S.* (1861) 4 6

EQUAL ALTITUDES.

Tables for Facilitating the Method of Equal Altitudes, by *F. A. L. Kitchin, B.A., Naval Instructor, R.N.* 1 0

COMPASS.

Rev. William Hall's Visible Astronomical Compass. for Lat. 50. Channel and adjacent zone. Important for sea and air navigation, size, 6in. diameter 1 0

An Explanation of the Adjustment of Ships' Compasses, illustrated with numerous diagrams, by *Captain the Honourable Wentworth Chetwynd, R.N.* ... 2 0

Handbook to Beall's Compass Deviascope, by *Captain George Beall,* contains, in addition to a complete explanation of this well-known instrument, much information necessary to compass correction 1 6

Elementary Manual for the Deviations of the Compass in Iron Ships, intended for the use of Seamen of the Royal Navy and Mercantile Marine, and Navigation Schools, by *E. W. Creak, C.B., F.R.S., retired Captain, R.N.* 6 6

Practical Information on the Deviation of the Compass, for the use of Masters and Mates of Iron Ships, by *J. T. Towson, F.R.G.S.* ... ...

AND

Supplement to the above; being the Questions on the Deviation of the Compass issued by the Board of Trade for the Examination for Masters' and Extra Masters' Certificates, and Answers to the Questions, by *Capt. William Mayes, R.N.* 4 0

The Roxburgh Compass Error Card. For quickly and accurately correcting True and Compass Courses and Bearings by a New Method; extremely simple and easy to work. Size 10 × 11 inches, printed in black and red; varnished. By *C. R. Wylie* 3 0

The Pocket Compass Corrector. Makes an error in applying variation and deviation almost impossible 2 0

The Binnacle Compass, Corrected by itself, or the Deviation found with one Compass by both methods, and the Corrections applied, by *Capt. A. B. Becher, R.N.* 1 0

The Storm Compass, or Seaman's Hurricane Companion, containing a familiar explanation of the Hurricane Theory, by *Capt. A. B. Becher, R.N.,* illustrated with Diagrams and Accounts of Hurricanes 1 6

Plain Deviation Curve Diagram, by *Captain J. C. Robinson* 0 6

List of Nautical Works published by J. D. POTTER.

GREAT CIRCLE SAILING.

s. d.

A Chart of South Latitudes, beyond 20 degrees, to facilitate the practice of Great Circle Sailing; with an accompanying diagram for the determination of the courses and distances, by *Hugh Godfray, M.A.* 3 0

EX-MERIDIANS.

Davis's Ex-Meridian Tables and Supplementary Azimuths, by *P. L. H. Davis.* This important work contains Calculated Reductions to the Meridian for hour angles less than 75^m and altitudes lower than 84°, Declinations and Latitudes 34° and 64° N. and S. The use of the book is quite easy to anyone familiar with the Azimuth Tables. The Supplementary Azimuths, which accompany it, give bearings too near the meridian for inclusion in "Burdwood and Davis," which are now in great request for position lines and ex-meridian work 11 6

Tables for the Reduction of Ex-Meridian Altitudes, by *J. T. Towson, F.R.G.S.* 1 0

Ex-Meridian Diagram, by *F. A. L. Kitchin, B.A., Naval Instructor, R.N.* 1 0

HOUR ANGLES.

Tables of Calculated Hour-Angles and Altitude Azimuth Tables, 3° N. to 30° S. **Ex-Meridian Tables and Calculated Reductions and Azimuths of Bright Stars,** 60° N. to 60° S., by *H. S. Blackburne* 7 6

The Calculated Reductions and Azimuths of 27 of the brightest stars up to about one hour from Meridian above the Pole, and from two to three hours from the Meridian below the Pole for circumpolar stars, make accurate position finding from two stars at twilight simpler than by any previously published tables.

HYDROGRAPHICAL ENGINEERING.

An Essay on Hydrographical Engineering, as applicable to Floating Sea Barriers, Harbours, Batteries, Coast Defences, and Naval Fortifications, by *Capt. Adderly Sleigh, K.T.S., F.R.S.L.* (with Illustrations), (1859) 10 0

INTERPOLATION.

Notes on Interpolation, Mathematical and Practical, by *Rear-Admiral C. Shadwell, F.R.S.* 2 0

LATITUDE AND LONGITUDE.

On Finding the Latitude and Longitude in Cloudy Weather and at other Times, by *A. C. Johnson, R.N.* Enlarged to 56 pages, with Appendix and Part II. 6 0

Short Tables and Rules for finding Latitude and Longitude, by Single and Double Altitudes, Pole Star, Lunars, &c., by *A. C. Johnson, R.N.* 3 0

Scales of Latitude from 5° to 60° proportional to a scale of Longitude, where ¼ in. = one mile, arranged to facilitate the finding of position from two Sumner lines, by *R. E. Peake, A.M.I.C.E.* ... ... per set 5 0

Charts to accompany above ... ... each 2 6

Tables showing the Length in Feet of a Degree, Minute, and Second of Latitude and Longitude, with the corresponding number of Statute Miles in each Degree of Latitude; and the number of Minutes of Latitude or Nautical Miles contained in a Degree of Longitude, under each Parallel of Latitude, by *R. C. Carrington, F.R.G.S.* (1868) 1 0

LAW.

Handbook on the Law and Practice relating to Apprentices to the Mercantile Marine Service, by *F. W. Gardner* (of the Middle Temple) ... 1 6

LIGHTS.

Light Range Table (height of light, 10 to 1000 feet; and height of eye, 10 to 120 feet), compiled and arranged by *J. S. Commander, Master Mariner* 0 6

Lights in Lyrics, or a Glance at the Channel Lights as Piloting Marks, on a run from Scilly to the Nore, accompanied by a Parting Precept on **Compass Deviation,** addressed to all younger Mariners. With a view of the Casquets, Notes and Charts. (1859) 1 0

List of Nautical Works published by J. D. POTTER.

LUNARS.

s. d.

Notes on the Reduction of Lunar Observations, Mathematical and Practical, by *Rear-Admiral C. Shadwell, F.R.S.* (1881) 4 6

See also **Latitude and Longitude.**

LOGARITHMS.

Davis's Requisite Tables (Logarithmic), by *P. L. H. Davis.* Tables of Logarithms to five places of decimals only, for practical sea work. The typography and arrangement of the book will render it suitable for habitual use, and it contains a table of Logarithmic and Natural Haversines specially designed for modern navigation 7 6

Davis's Five-Figure Logs and Anti-Logs, by *P. L. H. Davis.* Specially prepared for use in Actuarial and General Calculations. These tables are very legible and do not fatigue the eye in use 5 0

Ditto ditto ... ... with Index Tabs... ... ... 6 0

MAST-HEAD ANGLES.

Tables of Mast-Head Angles, for five feet intervals, from 30 to 280 feet, and varying distances from a cable's length to four miles, with their application to Nautical Surveying; also the determination of distance by sound, with an example... ... 2 0

MEASURES.

Foreign Measures and their English Values, compiled from Official Sources, by *R. C. Carrington, F.R.G.S.* (1864) 7 6

MERCANTILE MARINE.

A Voice from the Quarter-Deck on the State of our Mercantile Marine, by *Joseph Mayne* (Master Mariner) (1876) 1 0

An Address delivered to the Boys of the Training Ships "Chichester" and "Arethusa," by *G. M. Coxhead* (1885) 0 4

METEOROLOGY.

Solectrics; a theory explaining the causes of Tempests, Seismic and Volcanic Disturbances, and how to calculate their time and place. Illustrated by over 100 diagrams, by *Alfred J. Cooper,* Navigator. (Second Edition) 6 0

The Causes of Weather and Earthquakes (with four Diagrams), by *Alfred J. Cooper* (1902) 2 0

Light as a Motive Power, a Series of Meteorological Essays (1875), by *Lieut. R. H. Armit, R.N.* 15 0

See also **Winds.**

REVERSIBLE TRANSIT INSTRUMENT.

Notes on the use of the Portable Reversible Transit, and the Method of Calculation of the Observations, with diagrams and photographs, by *Capt. C. E. Monro, R.N.* 3 0

ROYAL NAVY.

Chart of the Navy of Great Britain, from the Earliest Period of History, compiled from Historical publications, old records, Parliamentary returns, and other authorities, by *Frederick Perigal* (of the Admiralty), 1860 ... ... 3 6

RULES OF THE ROAD.

The Rules of the Road at Sea, comprising the Regulations for preventing collisions at Sea, 1897, and Rules in force in Harbours, Rivers, and Inland Waters; with explanatory notes and observations, by *H. Stuart Moore, of the Inner Temple and the Admiralty Court, Barrister-at-Law.* (Third Edition) 7 6

Diagrams, with Explanations, illustrating the Rule of the Road for Sailing Ships, by *Capt. H. S. Blackburne* 2 0

3 H (How's Her Head) Indicator and Rule of the Road at Sea, by *George Spillane* 1 6

List of Nautical Works published by J. D. POTTER.

NAVIGATION AND NAUTICAL ASTRONOMY.

s. d.

The "Conway" Manual of Navigation. In this book of 80 pages nothing is taken for granted. All formulas are proved and the dependence of Navigation and Nautical Astronomy upon the solution of Plane and Spherical Triangles is clearly brought out. Particular emphasis has been laid upon method. By *J. Morgan, M.A. (Senior Master) and T. P. Marchant, A. L. Wood (Navigation Masters), H.M.S. "Conway" School Ship* 5 0

Nautical Astronomy, by *W. P. Symonds (Ex.-Commissioner of Surveys).* The best methods of calculating Hour-Angle, and finding Longitude and Latitude. The shortest Ex-Meridian method with New Table. Sidereal and Mean Time made clear. The New Navigation explained and the Modern methods of working Double Altitudes, and drawing Position lines. The Equation of Equal Altitudes made easy, and used for finding Longitude from Ex-Meridians, and for determining error in Latitude due to Ship moving N. or S. Lunars simplified. Chapters on finding Distances, the Tides, &c., with many diagrams 6 0

Nautical Astronomy Made Easy, by *A. C. Johnson, R.N.* All the Rules being worked by a Small Table on One Page, designed to economise Time and Labour ... 3 0

An Introduction to the Practice of Navigation and Nautical Astronomy, by *R. E. Hooppell, M.A., F.R.A.S.* 3 6

The Practice of Navigation and Nautical Astronomy, complete with tables, by *Lieut. Raper, R.N.* ... ... (*See also* the "New" Navigation) 18 0

Nautical Tables, by *Lieut. Raper, R.N.* ... ... (do., do.) 14 0

Inman's Nautical Tables. A New Edition of this standard work, revised and brought thoroughly up to the present date, by the *Rev. William Hall, R.N.*, and containing all the aids to rapid fixing of position which are essential in modern Navigation 18 0

Lectures on Elementary Navigation, by *Rev. J. B. Harbord, M.A. (Retired Naval Instructor, R.N.; late Inspector of Naval Schools, Admiralty; Examiner in Navigation and Nautical Astronomy for the Department of Science and Art; Author of "Glossary of Navigation")* 7 6

Navigation Simplified, by a System of Teaching based on First Principles, for Officers (from 2nd Mate to Extra Master) in the Mercantile Marine and Yachtsmen. Illustrated by numerous diagrams, by *Captain P. Thompson, F.R.A.S., Younger Brother of the Trinity House, Senior Examiner of Masters and Mates, and Secretary to the Local Marine Board of London* 12 0

Examination Diagrams Simplified, for Navigation Students; illustrated by sixteen diagrams (including 5½ inch Boxwood Scale), by *Captain P. Thompson, F.R.A.S.* 2 6

Navigation, intended for Self-Instruction up to the Second Mate's Examination, by *William Roy* 0 6

Practical Coastal Navigation, with numerous charts and diagrams, by *Count de Miremont* 4 0

Tables of Allowance for Current when affecting Compass Course and Ship's Speed, by *Capt. G. E. Hoar, War Department Fleet.* A small and convenient Table to give by inspection the correction to a Compass Course made necessary by a Current in any direction, and the resulting distance made good. A desirable book for all Coastwise Navigation 2 0

"THE 'NEW' NAVIGATION."

Appendix to Raper's Practice of Navigation. Being an explanation of the New Astronomical Navigation by the method of Calculated Zenith Distances, with Special Tables for Simplifying and Shortening the work, by *William Hall, R.N., F.R.A.S., Chaplain and Naval Instructor (Chief Naval Instructor, Royal Australian Navy)* 1 0

See also **Altitude Tables.**

List of Nautical Works published by J. D. POTTER.

SAILING DIRECTIONS.

	s.	d.
Canadian North Atlantic Steamship Routes between the British Isles and Canada. Distance, Latitude, Longitude, Variation, and true Course, by *R. A. Woodward, Lieut. R.N.R.*	5	0
Correct Magnetic Courses and Distances, from and to Various Ports round the British Isles, by *Arthur Underhill, LL.D., Commodore of the Royal Cruising Club,* assisted by several Members of the Club. Second Edition	2	0
Concise Navigating Directions for the River Thames, including all the Pools, Reaches, and Channels, from London Bridge to the South Foreland and Orfordness, and for the English Channel to Beachy Head; also for the Port of Dunkerque and the approaches to the Scheldt, by *Stephen Penny, Trinity Pilot, Gravesend* (illustrated by nineteen Charts)	7	6
East Coast Rivers. Charts and Sailing Directions for the Rivers Roach, Crouch, Blackwater, Colne, Stour, Orwell, Deben, Ore and Alde; together with General Charts from the Thames to Southwold, by *Lieut. S. V. S. C. Messum, R.N.*	5	0
The Pilot's Guide for the English Channel (with which is now incorporated "The Pilot's Handbook for the English Channel" by Staff Commander J. W. King, R.N.), comprising the South Coast of England, and general directions for the Navigation of the Channel; with numerous Charts and Plans of Harbours, edited by *H. D. Jenkins, F.R.G.S.*	7	6
Yacht Cruising, illustrated with drawings and sketches, by *Claud Worth.* (This book consists partly of "logs" of cruises and partly of articles and notes on various matters connected with cruising)	7	6
A Chart of the Dutch Waterways, by *J. & A. B. Powell*	4	0
From Calcutta to Bombay Coasting, being the Second Edition of the Handbook to the Ports on the Coast of India between Calcutta and Bombay, including Ceylon and the Maldive and Laccadive Islands, with 11 Charts and 12 Photographs, by *Lieut. H. S. Brown, R.N.R.,* Port Officer, Marine Department, Madras Presidency.	10	0
The Occurrence and Paths of Storms, and the Method of Avoiding Damage from Them, by "*Kalb Siad.*" An Essay on "The occurrence and paths of those storms known as 'Cyclones,' as they are encountered in Eastern Seas between Aden and Singapore, including the neighbourhood of Mauritius and that part of the Indian Ocean between Mauritius and India. Also the method of avoiding damage from them"	1	0
Winds and Currents of the Mediterranean, by *Capt. A. B. Becher, R.N.,* with remarks on its Navigation at different Seasons of the Year, compiled from various authorities, chiefly Spanish (1864)	3	0
Navigation of the Atlantic Ocean, by *Capt. A. B. Becher, R.N.,* with an account of the Winds, Weather and Currents found therein throughout the year (with Charts) (1892)	5	0
Navigation of the Indian Ocean, China and Australian Seas, by *Capt. A. B. Becher, R.N.,* with an account of the Winds, Weather, and Currents found therein throughout the year (with Charts) (1864)	5	0
Chart of the Sulina Branch of the Danube (European Commission of the Danube), surveyed by Robert Hansford, Surveyor of the Commission, under the direction of C. A. Hartley, Engineer in Chief (showing 45 nautical miles of the River from Sulina), size 10 ft. × 2 ft. 3 in. (1860)	20	0
Notes on Cherbourg (Geographical and Historical description of, &c.), and Chart (1858), by *Commander Bedford Pim, R.N., F.R.G.S.*	1	0

SALVAGE.

How Ships are Lost, and How to Save Life and Property at Sea (Illustrated), by *W. P. B. Manser* (1877)	1	0

List of Nautical Works published by J. D. POTTER.

SEAMANSHIP.

	s.	d.
Under Square Sail, by *Capt. Withers* (1898)	2	0
Under the Red Ensign; or, "Going to Sea," by *Thomas Gray* (1892) ...	1	6

SEXTANTS.

Stars and Sextants. Star Distance Tables for facilitating the use of Lord Ellenborough's method of Correcting the Centring and Total Errors of Sextants at Sea, by *John Abner Sprigge, Wm. Fraser Doak, M.A., F.R.A.S., T. Charlton Hudson, B.A., F.R.A.S., of H.M. Nautical Almanac Office, Admiralty,* and *Arthur S. Cox, B.Sc., A.R.C.S.* 2 6

Captains' and Officers' Bridge or Poop Companion. Tables for finding the distance of an object at sea by inspection (without the use of pencil or paper), at the same time giving the distance the ship will go wide of the object before getting to it, and the course to steer to obtain a required distance. The above gives, with the aid of a compass only, the distance of a moving ship from any fixed object. By *A. Hütteroth* 2 6

Course and Position by Sextant Observations of two known Objects, *by Lt.-Col. English, late R.E.* 0 6

SHIPPING.

Historical Notes on Shipping, by *P. L. Isaac, M.I.N.A.* (1879) 1 0

SPEEDS.

Speed and Consumption of Steam-Ships and Stability, with Algebraic Formula for Economical Speed, and Rules for calculating the alterations in Draught and Trim corresponding to Changes in Displacement, and for using the Hydrometer to estimate those due to Differences in the Specific Gravity of the Water; for use in the Royal Navy and Mercantile Marine; to which has been added a Chapter on Stability, with Practical Rules; Second Edition, Revised and Enlarged, by *J. F. Ruthven, Master Mariner, late Lieut. R.N.R., Assoc.Inst.N.A., Younger Brother of the Trinity House, F.R.G.S.* 4 0

Speed Tables, for finding the distance run in a given time at a given speed, between the limits of 10 to 18 knots, by *J. D. Macpherson* (Pacific Steam Navigation Co.) ... 1 0

STABILITY.

A New Theory of the Stability of Ships, second edition, revised and enlarged (with 28 diagrams), by *Alf. J. Cooper* (1899) 2 0

See also **Speed and Consumption of Steamships.**

STARS.

Steering by the Stars, for Night Flying, Night Marching and Night Boat-Work, between Lat. 40° N. and 60° N., with Sketch Maps and Directions for finding the selected Stars. By *James Dundas White, LL.D., M.P.* 1 0

Position-Line Star Tables. A new and simple method of fixing ship's position by observations of stars near Meridian and Prime Vertical without logarithmic calculation, by *H. B. Goodwin, R.N.* [These Tables have been adopted officially in the United States Navy.] 5 0

The Bearings of the Principal Bright Stars of greater declination than 23° north or 23° south; also those of the Moon and Planets when similarly situated, by *A. C. Johnson, R.N.* (Published by request) 3 0

Pole-Star Latitude: a Method of Finding the Latitude from an Altitude of the Pole Star, by *Darnton Hutton* (Master Mariner), *B.A., M.Inst.C.E.* 1 0

Tables for Facilitating the Determination of the Latitude and Time at Sea by Observations of the Stars, by *Rear-Admiral C. Shadwell, F.R.S.* 2 6

A Handbook for Star Double Altitudes, by *A. C. Johnson, R.N.*, with directions for selecting the Stars 2 6

See also **Sextants.**

List of Nautical Works published by J. D. POTTER.

SIGNALS.

s. d.

Signal Cards—British System, with Plates, containing Instructions for Semaphoring by **Day,** and with the Morse Code by **Day** or **Night,** together with the principal "Urgent" Light or Sound Signals, in accordance with the New Code. Also, Sheet of New Code Flags (34 Flags, coloured). Compiled by *J. Whitly Dixon* (*Retired Captain, Royal Navy*). (Size, 24½ × 19½) 1 6

Ditto ditto mounted on thick card 2 0

SURVEYING.

Practical Nautical Surveying and the Handicraft of Navigation, by *Com. T. A. Hull, R.N.* 3 0

Practical Observations on Surveying (on determining the Position of a Vessel when Sounding), by *Commander P. F. Shortland, R.N.*... ... ... 1 0

TIDES.

"How far is that Light?" Tables to allow for current in finding the distance by doubling the angle on the bow, by *Fredk. Ball, M.A.* 1 0

Capt. D. Fulton's Tidal Diagram, an easy and ready method of computing the correction to be applied to the soundings, mounted on stiff cardboard with Rule and Case complete 4 0

Moxly's Theory of the Tides, with numerous diagrams, Second Edition, Revised and Enlarged, by *Capt. J. F. Ruthven, F.R.G.S.* 5 0

Tide Charts of the English and Bristol Channels and entrance of the Thames, compiled from the Admiralty Tide Tables, by *Algernon Heber Percy,* late Lieut. Royal Navy 5 0

The Direction and Rate of the Tidal Streams at every Hour, for 48 Localities between the Nore and Scilly Isles, compiled from Admiralty Sources only, by *F. Howard Collins* 2 0

The General Direction of the Tidal Streams in the North Sea for every Hour "before" and "after," and at High Water, Dover, compiled by *Com. G. K. Gandy, R.N.R.,* from Official Publications (on one sheet, size 23 by 17 inches) 1 0

The Universal Tidal Ready Reckoner, calculated by *Capt. W. E. Hutchinson.* 1 6

The North Sea. Its Physical Characteristics, Tides, Currents and Fisheries, by *W. H. Wheeler, M.Inst.C.E.* 2 6

TIME.

How to Find the Time at Sea in less than a Minute, being a New and Accurate Method, with specially adapted Tables, by *A. C. Johnson, R.N.* 2 6

Time, Tide, and Distances. A handy book of reference for the Shipowner, Underwriter, or Traveller. Contains the World's Time compared with Greenwich; the Tides round the British Coasts and those from Bergen viâ the Eastern Route to Japan with that at London Bridge; approximate Distances from Home Ports to Home and Foreign Ports (over 13,000 references); and a Speed and Distance Table for Rates of Speed from 8 to 21 knots for distances up to 14,000 nautical miles, by *J. McKirdy, R.N.R.*... ... ... 15 0

Time-Altitudes for Expediting the Calculation of Apparent-Time, &c., by *A. C. Johnson, R.N.* 4 0

The Blue Coat Boys' Clock. A dial showing the simultaneous time of day at all parts of the earth's surface, size 20 × 17 inches 5 0

List of Nautical Works published by J. D. POTTER.

WINDS.

	s.	d.
The True Direction and Velocity of Wind, observed from Ships while Sailing, by *James N. Miller* (Member of the Liverpool Polytechnic Society), with Table for Indicating the True Direction of the Winds at Sea (1870)	0	6
The Wind in its Circuits: with the explanation of the Origin and Cause of Circular Storms and Equinoctial Gales; illustrated with numerous Diagrams and a Chart of the Prevailing Winds of the World for Spring and Summer, by *Lieut. R. H. Armit, R.N.* (1870)	7	6

USEFUL PUBLICATIONS FOR YACHTSMEN.

Amateur Sailing. Reminiscences by *C. F. Abdy Williams*	4	0
Yacht Cruising, illustrated with drawings and sketches, by *Claud Worth* ("Logs" of cruises and notes on various matters connected with cruising)	7	6
Navigation Simplified, by a System of Teaching based on First Principles, for Officers (from 2nd Mate to Extra Master) in the Mercantile Marine and Yachtsmen. Illustrated by numerous diagrams, by *Captain P. Thompson, F.R.A.S.*...	12	0
Practical Coastal Navigation, with charts and diagrams by *Count de Miremont*	4	0
Concise Navigating Directions for the River Thames, including all the Pools, Reaches, and Channels, from London Bridge to the South Foreland and Orfordness, and for the English Channel to Beachy Head; also for the Port of Dunkerque, and the approaches to the Scheldt, by *Stephen Penny, Trinity Pilot, Gravesend* (illustrated by nineteen charts)	7	6
East Coast Rivers. Charts and Sailing Directions for the Rivers Roach, Crouch, Blackwater, Colne, Stour, Orwell, Deben, Ore and Alde; together with General Charts from the Thames to Southwold, by *Lieut. S. V. S. C. Messum, R.N.*	5	0
The Pilot's Guide for the English Channel (with which is now incorporated "The Pilot's Handbook for the English Channel"), comprising the South Coast of England and general direction for the Navigation of the Channel; with numerous Charts and Plans of Harbours, edited by *H. D. Jenkins, F.R.G.S.*	7	6
A Chart of the Dutch Waterways, by *J. & A. B. Powell*	4	0
Correct Magnetic Courses and Distances, from and to Various Ports round the British Isles, by *Arthur Underhill, LL.D., Commodore of the Royal Cruising Club*, assisted by several Members of the Club. 2nd edition ...	2	0
3 H (How's Her Head) Indicator and Rule of the Road at Sea, by *George Spillane*	1	6
The Roxburgh Compass Error Card. For quickly and accurately correcting True and Compass Courses and Bearings by a New Method; extremely simple and easy to work. Size 10×11 inches; varnished. By *C. R. Wylie*	3	0

ADMIRALTY CHARTS.

Official Catalogue of Admiralty Charts, Plans, and Sailing Directions. A Vol. of 330 pages and 24 Index Charts... ... ... *No charge.*

On the Correction and Use of Charts, Light Lists, and Sailing Directions. 40 pp., bound red cloth ... ... *No charge.*

British Admiralty Charts

PUBLISHED BY THE HYDROGRAPHIC DEPARTMENT.

Comparative Statement, giving the number of New British Admiralty Charts published, Corrections made to the Chart Plates, and Number of Charts printed, for various years from 1879 to 1913, shewing the large increase of work in the Department during that period.

Years.	New Chart Plates Engraved and Published.	Chart Plates Improved by Additional Plans.	Chart Plates Improved by Large Corrections and Additions.	Minor Corrections Made to the Chart Plates.	Minor Corrections at the hands of the Draughtsmen.	Notices to Mariners issued.	Number of Charts Printed for the Royal Navy, Government Departments, and the General Public.
1879	62	20	140	1,880	21,550	205	192,060
1890	76	10	136	4,750	37,270	723	297,120
1900	102	30	224	4,520	35,500	874	580,207
1905	110	36	196	5,320	60,499	1,392	689,930
1913	50	45	1,196	9,309	169,064	2,030*	889,336

(The figures for years 1914, 1915, and 1916 not yet available.)

* Of each of these Notices over 10,000 copies are printed off weekly and distributed gratis to the British and Foreign Mercantile Marine Services, Yachting centres, and the general Shipping public, as well as to H.M. Fleet.

BOOKS OF SAILING DIRECTIONS HAVE BEEN PUBLISHED FOR EVERY SEA.

CATALOGUES (GRATIS) FROM
J. D. POTTER, 145, MINORIES, LONDON, E.C.